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A NEW METHOD OF INCORPORATING METEOROLOGICAL SATELLITE DATA INTO GLOBAL CROP MONITORING*

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ABSTRACT

An inexpensive and effective method of monitoring vegetation using NOAA/AVHRR satellite data is presented as an integral part of a global crop monitoring system. The satellite monitoring subsystem increases the value of the meteorological and agronomical subsystems, but cannot stand alone as an assessment system. The satellite monitoring subsystem is based on a new color coordinate system which maximizes the information content of satellite images and minimizes the analysis time. The color coordinate system is described and compared to other systems.

1. BACKGROUND

Drought Early Warning System

As part of the Agency for International Development's Office of Foreign Disaster Assistance (AID/OFDA) disaster preparedness program, the National Oceanic and Atmospheric Administration (NOAA) has developed a drought early warning system for food crops in the tropics. The system provides routine operational drought impact assessments to US Embassies and AID missions in five tropical regions -- Africa, South Asia, Southeast Asia, Central and South America, and the Pacific Islands.

As would be expected, the drought early warning system is based on the detection of below normal rainfall during the growing season. To do the job several types of information are required, for no single data system can provide the complete answer to the question of food production. Operational production of the assessments is a key factor in the success of the project. Operational assessments provide a focus for the system development, serve as a test of new techniques, and provide an important check on the cost of the new assessment tools. Resource limitations are a very real constraint and must be used to judge any new assessment tool.

The detection of drought is not as simple as it may appear. Both the estimation of rainfall and the determination of drought, once the rainfall is known, are complex problems. Estimation of the rainfall over a large area is complicated enough, but once the rainfall amount is known for an area there remains the problem of determining whether or not there is a drought. There is no definition for the onset of drought. Drought is a direction, not a location. The word drought can be compared to the use of the word cold. There is no set temperature at which something is cold, rather cold is a direction which is the opposite of warm. Drought is the

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opposite of wet, but there is no one point on any drought scale which marks the beginning of a drought.

Multiple Subsystems

Other information must be combined with the weather data to determine both the amount of rainfall and the status of drought. Satellite data provide additional rainfall information and agronomic, climatic, economic, and political data help detect the onset of drought in each region. All of these data sources form the basis for subsystems which must be combined to produce the best possible operational, early warning assessments of drought. The major subsystems in the program are agricultural, climate, and satellite.

The agricultural subsystem is the starting point for evaluating the impact of climate on crop production. Included in the agricultural system are farming practices, the geographic distribution of crops, plant phenology (timing of the stages of plant development), physiology, economics and, in some cases, politics. No assessment is possible without knowing where the various crops are grown and how they are grown, but that is not the complete picture. It is necessary to understand how various crops in different stages react to the weather conditions and how weather conditions control crop stage. Other information that is important is the amount of fertilizer used, and the political stability of the region as it affects the demand for food and the supply of farm labor.

The weather and climate subsystem provides the all-important rainfall data, and is composed of rainfall reports from rain gauge measurements, the evaluation of large scale weather systems, and the climatology of the regions. Available rainfall reports are sparse in many tropical regions. Even in areas where dense reporting networks are in place, these data are frequently not transmitted to the international scientific community in real time. When station reports of current weather are available, rainfall amounts are the least important of all the reported elements and are, therefore, the least reliable. Rainfall amounts have no use in aviation and are of limited use to weather forecasting, the two major uses of transmitted weather data. Moreover, if the weather reports did contain completely accurate information they would not tell the whole story because rainfall is not a continuous parameter. When the majority of the rainfall comes in the form of showers, as it does in the tropics, rainfall amounts differ widely over short distances. A single rain gauge may be a poor estimator of rainfall over a large area.

Large-scale pressure patterns and the climatology of each region must be analyzed with the rainfall reports to remove errors in the data and produce accurate large-area rainfall estimates. These analyses are subjective and require years of training and experience. A valuable addition to the solution of the rainfall measurement problem has been meteorological satellite (met-sat) data.

2. SATELLITE SUBSYSTEM

Rainfall Estimation

If clouds are absent over a region during the rainy season, there is a drought in that region. This simple fact allows for the use of met-sat data to determine the large area rainfall amounts from an independent data source. NOAA met-sat data covers the world twice a day and can determine where it is not raining on each pass. Moreover, a trained technician looking at the met-sat images can identify cloud types which have a high chance of producing rainfall. An estimate of monthly rainfall for the region can be computed by totaling the daily percentage coverage of rain-producing clouds. The units of these estimates are in millimeters of rainfall, but they are more accurately thought of as probabilities of drought. When estimates are low, the cloud cover has been below normal and rainfall is certainly less than normal.

Computer analysis of the brightness of each picture element (pixel) can be used to automate the system and produce global assessments of drought probability from both current data and historic data sets. This system should not be confused with other met-sat based rainfall estimation systems which produce point specific rainfall estimates on a daily basis. These systems require a great deal more data and are much more complex. The result is an increase in cost of a factor of 100 or more. Resource limitations prevent systems of this type from being used to monitor the globe in an operational mode. Crop assessment does not require this degree of accuracy, and the simpler mean monthly cloud measurement system is both sufficient for the assessment process and affordable.

Surface Monitoring

There is general agreement that met-sat data contain valuable information about the status of the crop, but existing systems either do not work very well, they are extremely expensive to operate, or both. What is needed is an inexpensive system which will provide useful information over large areas in the tropics. The solution is to do qualitative analysis to remove the need for atmospheric corrections, which accounts for most of the analytical difficulties and costs, and to use low resolution data to reduce storage and processing costs.

Resolution has been one of the most serious problems in satellite monitoring of vegetation over the past several years -- there has been too much of it. For many applications, increased resolution does little more than geometrically increase the cost of analysis. Large-scale crop monitoring requires large-scale analysis, and every application of satellite monitoring requires as complete a data set as possible. The trick is to get a complete data set that is small enough to analyze and store. Once the complete data base is in place, higher resolution data can be included as subsets of the low resolution data set, and the low resolution data can be used to put the higher resolution data into context.

Any data base which requires more than a computer tape per week to store its data quickly looses its flexibility. Processing real time data becomes a full time job for someone, storage and retrieval quickly become a problem, and processing historical data becomes a chore which must be scheduled weeks in advance. In short, the responsiveness of the system to innovative analysis and development of new assessment tools drops dramatically.

The size of the data base is a function of both the spatial and temporal resolution. Met-sat data for crop monitoring is available daily for the entire world. A week of these data can be stored on a single computer tape if the spatial resolution is of the order of 20 kilometers. A polar stereographic (PSG) grid measuring 1024 by 1024 pixels meets the resolution requirement and serves as the primary data base for this project. This resolution allows an entire continent to be displayed on a standard image processor as a single image. This resolution is sufficient to monitor the general crop status of several hundred crop regions in the tropics.

Qualitative Analysis

All satellite data should be thought of as qualitative data, and any system that treats it as quantitative introduces problems that are difficult if not impossible to solve. If the satellite was bolted to a stable platform a few meters from the crop, looked at the crop at the same angle on each acquisition, and the light source was constrained in the same way, then these data could be considered to be quantitative. For example, a reading of 12 for hannel I and a reading of 30 for channel II could be used as a specific measure of biomass of the plant being measured. If the sensors on the satellite were looking straight down through a vacuum, these data could also be used quantitatively. However, these data become qualitative when the gases, liquids, and particulates of the atmosphere interact with the sun's radiation, the viewing angle is constantly changing, and the

sensors in the satellite drift.

Any system which attempts to remove the effects of the atmosphere and make these qualitative data into quantitative data must be expensive and will likely not succeed completely. All of the gases and particulates that cause radiation to change as it passes through and bounces off of parts of the atmosphere vary over time and space in a very complex manner. To remove the effect of these contaminants a complex, dynamic model of the atmosphere and detailed particulate measurements must be combined and run for the entire globe, and results returned for each pixel as a function of look angle. The cost of such a model would be prohibitive if it existed, and neither the model nor the particulate data exist at the scale needed.

Much simpler models can be designed to remove some of the noise caused by the atmosphere, but to a large degree the data remain qualitative. By qualitative we mean that the exact value of any measurement from a satellite is not the same as it would be if taken from the surface, but the relative values of adjacent pixels will remain in the same relative position regardless of the atmosphere. If the measurement from pixel 1 is greater than that from pixel 2, it will remain greater, or become the same under complete cloud cover, but it will never become less. The absolute value of each may increase or decrease by some amount, their ratio may change, and the difference between them may change, but their positions will not reverse.

To the physical scientist it may seem that all of the value of the information is lost if only the relative values remain. This is because the physical scientist has been trained to work with quantitative data. These data contain noise, but the underlying values are quantitative -- a 12 may be hard to measure, but when it is measured it will be a 12. Since physical scientists are the people who do this analysis, the first step has always been to remove the noise caused by the atmosphere. If this cannot be done economically, an expensive and ineffective product usually results.

There is one processor that, by design, processes only qualitative data, and actually cannot process quantitative data -- the human mind. Images seen by the eye are transmitted to the brain as relative patterns at the expense of quantitative measurement. How this is done is only now beginning to be understood, but the reason for it is simple. Lighting and viewing conditions are constantly changing in nature, just as the atmosphere is changing for the satellite. The time of day changes the sun angle and shadows, clouds and other objects reflect the sun, fog dust and haze are frequently present, and the light source may be the moon or a fire rather than the sun. If our distant ancestors had been required to store in their brains separate information for each scene under every possible lighting and viewing condition, we would not be here today. By the time a threat to life or to a source of food would have been recognized the poor creature would have died from attack or starvation. In any case, a brain that could store this much information probably could not be carried by the body it served, so a better solution was needed.

The solution was to store only the general pattern as discerned by relative differences between the background and the pattern of interest. There are a number of optical illusions which amaze people who do not realize that the mind cannot quantify. An illusion which best illustrates this fact and serves to explain why the color system proposed below works is a simple color chart in a paint store. These charts normally are made up of adjacent squares of different colors called paint chips. If the colors are very different, such as bright red, green, or blue, the mind sees them as they are. If, however, the color or brightness change is small, as in subtle shades of pink, the mind enhances the difference to make the change more noticeable. The result is the appearance of sharp borders between the color chips and an apparent reverse gradient across the chip. If the surrounding colors are covered by a mask, the illusion disappears, but returns when the mask is removed. There is no way to defeat this illusion, and the color coordinate discussed below uses this talent to

analyze images for crop vigor.

Photo Interpretation

Nothing that has been said so far has been news to the photo interpreter (PI), but some of it probably was to the image analyst who has been trained as a physicist and has had no PI training. The solution that is presented here is simply to use what we know about the physics of the situation to produce an image that makes it as easy as possible for a PI to see how the vegetation is doing while reducing the possibility of confusion by the atmosphere. This is not as difficult as it sounds, because there is a big difference between confusion and annoyance. Clouds, for example, have distinctive patterns which are easily identified as clouds in an image. The presence of clouds is an annoyance to a PI, since they block the surface, but they do not confuse because they are seen for what they are and they are not confused with surface features.

If the scene is correctly displayed to minimize the confusion and maximize the wanted information, it is fairly easy to train people who are familiar with the situation to use the satellite data to enhance their understanding of what is happening on the ground. This is a key point. If satellite data are used qualitatively, they must be combined with other data to produce quantitative answers. These other data include recent weather, climatology, cropping practices, and economics. These data are quantitative, but they are usually coarse in their spatial and temporal distribution. The satellite data can be used to interpolate these data, to make gross value checks, and to fill in data gaps.

False Color IR

There is already a system in use which fulfills the requirement of minimized confusion. The system has been used for aerial photography, Landsat, and NOAA AVHRR crop condition assessments with some success by trained PI's. This system is the false color IR (FCIR) color coordinate system which is based on the shifting of the blue, green, and red towards the IR to accommodate the near IR channel (figure 2). Color film uses red, green and blue to reproduce all of the colors in a scene. The system works because these are the same as the receptors the eye uses to sense color. With the addition of the reflected IR light, one of the colors had to be dropped to make room for it. Since Rayleigh scattering produces a blue haze on color photographs taken from high altitude, the blue light was the band that was dropped. In this system green becomes blue, red becomes green and near IR is red.

The FCIR system is extremely useful for identifying vegetation because of a convenient accident of color coordinate system alignment. Quite by accident the mind's natural color coordinate system is aligned with the most commonly used vegetative indexes. The result is an image that contains all the useful information contained in the original data that is displayed in a way that the mind can directly evaluate a biomass as changes in color. These color changes are not arbitrary. They are seen by the mind as changes on a single orthogonal axis and patterns of biomass can easily be detected.

All studies of Landsat and AVHRR that have attempted to produce a single number (index) to describe the health of vegetation have begun with the difference between, or the ratio of, the near IR channel and one of the visible channels. One of the most common indexes is the difference divided by the sum, which is called the "normalized" difference vegetative index. It is this index that is displayed as changes in saturation in the FCIR coordinate system (figure 1).

This must be an accident because the FCIR system is a red, blue, green (RGB) display not an intensity, hue, saturation (IHS) display. The difference between these two coordinate systems is extremely important because, although the eye receives RGB information, the mind processes only

IHS information. The net result is that patterns of RGB in an image are totally invisible to a PI while IHS patterns are easy to detect.

For crop monitoring an FCIR display is basically a two channel RGB display of one visible and the near IR channel. The earth's surface shows relatively little change between the visible channels but shows dramatic variation between any of the visible channels and the near IR. To produce the FCIR display the brightness of the red gun in the CRT is controlled by the value of the IR channel, and blue and green are equal (or nearly equal in the case of three channel Landsat) and controlled by the visible channel. The result is a red and cyan (blue-green) display with natural brightness that is directly related to the "normalized" index values. Positive values (increasing biomass) are displayed as red, and negative values (water) are displayed as cyan. Where the two are equal the color is white or gray. Everything that is neither water nor vegetation lies along or very near this diagonal. The values of saturation computed from these colors are exactly equal to the index values. For example an index of 0.60 is displayed as a pink which is 60 percent saturated red.

Since changes in saturation of red are equal to changes in the vegetative index it is easy for a PI to make qualitative comparisons of the state of the vegetation on the ground -- the redder the better. This coordinate system has been in use for many years to discern features in the pattern of vegetative health. It is still the most useful, generally available method of analyzing imagery but it does have a serious flaw. The subtle changes in saturation may be sufficient to detect patterns, but they are too subtle to make any comparisons between points that are not adjacent. One of the reasons is the false gradient the mind creates when color change is too subtle to see easily. The other is that of the three axes of the IHS the saturation is the one with the worst resolution. Both intensity and hue are much easier to separate than saturation.

Arbitrary Index Coloring

There is a system that solves the problem of comparing non-adjacent colors, though it creates a set of its own problems. To understand the final system, which is what all of this is leading up to, we must understand this arbitrary index color system. The arbitrary index color system is at the opposite end of the coordinate system spectrum from the FCIR system. The Ambroziak color coordinate system will be shown below to be a combination of both of these systems.

The arbitrary index color system uses few colors. They are chosen to be as different from each other as possible so that they can be uniquely identified (figure 3). A narrow range of positive index values corresponds to each color except blue, which is assigned to negative values to denote water. This coordinate system shows sharp, easily identified boundaries and serves as a quantitative contour map of positive index values. It is an ideal presentation of the index, and if the effects of the atmosphere have been removed, it is the preferred method of displaying the index.

The arbitrary index color system, however, does not display all of the information contained in the original two-channel data, nor does it present a continuum that allows the relative comparisons that the mind does so well. It may be great for display, but it is a poor analysis tool. Dark soil, light sand and clouds all have the same index value and will appear the same in the arbitrary index color system. If brightness is included, the data loss problem is solved, but the lack of a continuum remains.

3. AMBROZIAK COLOR COORDINATE SYSTEMS

The natural first step toward improving the FCIR system is to replace the poorly resolved saturation with hue. The perceptual difference between red and orange (hue) is much greater than between red and reddish pink (saturation). The first Ambroziak color coordinate system (ACCS) assigned green to an index value of 1, red to 0, and blue to -1 (figure 4). The

result is a fairly natural looking scene with green vegetation, dark blue water, red and brown soils, and yellow stressed vegetation.

Clouds are bright red in this scheme which is annoying to the analyst. To remedy this problem, saturation is reduced to zero for the very high visible brightness values. Should a cloud filter become available, such as thermal detection, these data would be used to reduce saturation in a more efficient way. The presence of thin clouds or haze in a natural scene is discerned as a reduction in saturation. By making this change to the coordinate system the image takes on a more natural appearance.

This system proved to be extremely useful in monitoring the status of vegetation in the tropics during the northern hemisphere summer of 84. Test reports produced from only the images agreed closely with assessments produced from all other data sources. Patterns of drought and plentiful rainfall were shown in finer detail than was possible with the station data alone.

Assessors determined that the ACCS is a significant improvement over the FCIR system, but that it lacked the comparison of distant points capability of the arbitrary index color system. A step toward this goal is achieved by cycling the hues at twice the rate of that used on the ACCS. The result is the ACCS2 which assigns green to an index value of 1, red to 0.5, blue to 0, cyan to -0.5, and green again to -1 (figure 5). There is little or no chance for confusion between the two greens because all values below -0.5 are very dark and appear black on the image.

The ACCS2 is close to the arbitrary index color system in its color separation ability, yet it maintains all of the advantages of the FCIR system, making it an ideal tool for analysis. The ACCS2 images do not have the natural appearance of the ACCS, but this is of no concern to the analyst using them. Comparisons of cumulative rainfall and the images shows close agreement between the index and point station values of rainfall. By using the two data sets, detailed maps of cumulative rainfall can be produced. Other uses for the system are now under development.

Other Uses

The ACCS's have no dependence on AVHRR data and have been demonstrated to be useful in viewing Landsat images as well. Aerial photography can be digitized through filters and also can be converted to one of the ACCS's. These higher resolution data can be combined with the lower spatial resolution AVHRR to produce a more valuable data set than either alone. The AVHRR data has high temporal resolution and provides a complete overview data set. The higher resolution data can provide detailed closeups of areas determined to be of interest from analyzing the AVHRR.

To analyze the world the 20 km resolution sampled AVHRR data is a reasonable size, but if a single country or small region is the subject of the analysis then the 1 km resolution local area coverage (LAC) or high resolution picture transmission (HRPT) data would serve as the basic data set. In this case Landsat and aerial photography would provide the closeup views of the region.

The basic data set provides a complete record of historic data from the date acquisition begins. This data set becomes not only a valuable and inexpensive research tool, but it increases the value and decreases the cost of the higher resolution imagery. The value of the higher resolution imagery is increased by putting it into time and space context. The cost is reduced because less high resolution imagery is needed, that which is obtained contains important information, and cloud contaminated scenes can be avoided.

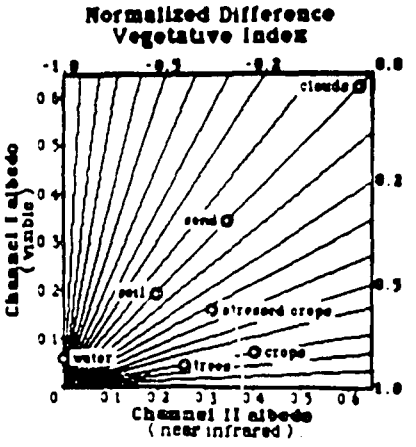


Figure 1

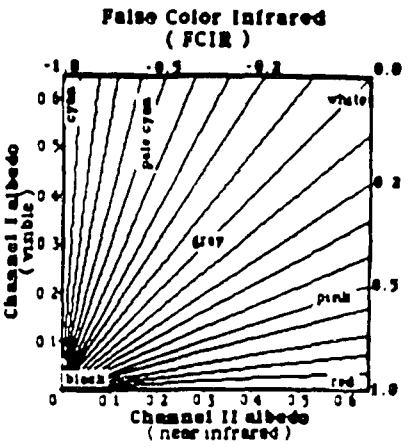


Figure 2

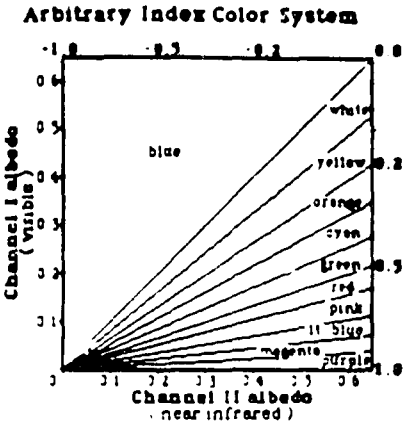


Figure 3

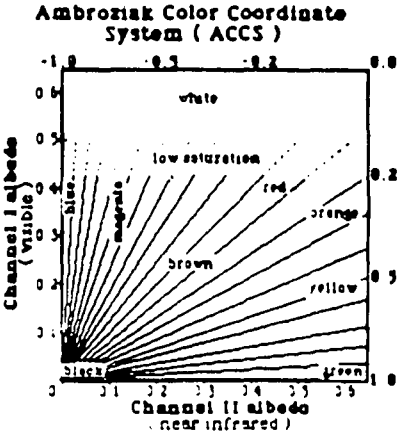


Figure 4

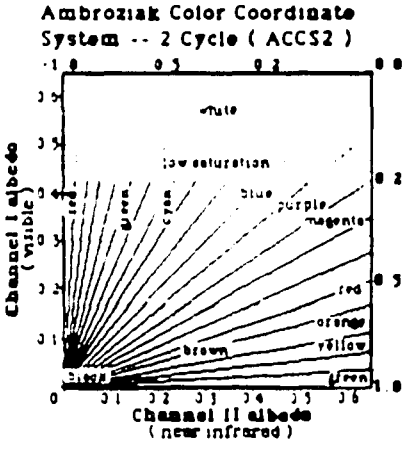


Figure 5

NIGER

SPECIAL AGROCLIMATIC ASSESSMENT OF THE 1984 SEASON

Prepared by the Climate Impact Assessment Division, Assessment and Information Services Center of NOAA - December 11, 1984

THE RAINFALL REGIME

In Niger, like in all other Sahel countries, the annual rainfall amount increases from north to south (Figure 1). The rainy season normally lasts about 3-4 months in the northernmost agricultural areas and about 5 months in the southernmost locations (Figure 4). In the south it normally begins in May and lasts until the end of September, while in the north the rainy season begins about a month later and ceases 2-3 weeks earlier. Because of the water availability this is also the crop growing season. The rest of the year is generally dry. Therefore rainfall amounts during the rainy seaon are the same (with few minor exceptions) as annual amounts.

THE AGRICULTURAL CROPS

The northern limit of rainfed farming in the Sahel is considered to be the 350 mm annual rainfall isohyet. Of certain agricultural importance are the pastures north of the 350 mm line to about the 200 mm isohyet.

Millet is the most important food crop in the country. It is usually interplanted with another food crop, mostly cowpeas, sorghum or peanuts. Sorghum is the second most important crop, often interplanted with cowpeas or peanuts. Other food crops, grown on a much smaller scale, are maize, rice (in the Niger River Valley), cassava (manioc), earthnuts (vouandzou), etc. Peanuts are grown mostly as a cash crop. Other cash crops are cotton and tobacco. The growing areas of some crops are shown on Figure 2.

THE CHANGING CLIMATE

The drought of 1984 is not an isolated phenomenon. Rainfall amounts in Niger began a decline around 1968 that has continued to the present. Rainfall amounts in Niger during the last 51 years (1934-1984) were analyzed on a zonal basis: with 200-500 mm and 500-900 mm annual rainfall. The zonal rainfall for each year is shown on Figure 3. Also indicated are the mean values for the 51 year period and the 5 year running averages. An analysis of the curves indicates that after the devastating droughts of 1972 and 1973, annual rainfall came close to normal for several years (1976-79). Another decline began afterwards, leading to even more devastating droughts in 1983 and 1984.

The droughts affected both natural vegetation and the agricultural practice. They also made obsolete the rainfall normals calculated for periods before the decline began. Shown on Table 1 are the mean annual amounts from various reference sources (calculated for periods before 1968 and still widely used in and outside Africa) and the mean amounts for the last 17 years. The descrepancy is obvious. Mean rainfall for the period after 1968 is mostly 20-30 percent lower. If a new map for the 1968-1984 mean annual rainfall in Niger were to be prepared, all those isohyets on Figure 1 would have to be moved southwards by about 70 kilometers (40-45 miles).

Besides the differences in the mean annual amounts of rainfall, the changing climate of the country has affected all other components of what is called "rainfall regime", such as number of rainy days, beginning and end of the rainy season, various confidence limits of rainfall (amounts that have certain probability of occurrence), etc. Naturally, the mean monthly, ten days and weekly rainfall amounts are also smaller.

AGROMETEOROLOGICAL ASSESSMENT OF THE 1984 SEASON

May. Three stations in the country - Gaya, Niamey and Birni N'Konni - received more or less sufficient rainfall (50-60 mm) for land preparation and even for sowing some crops (Table 2). It was beneficial also for the pasture vegetation in these areas.

June. This is the month when the rainy season normally begins over most agricultural areas in the country. This year's June was very dry. In the extreme south, Gaya reported 77 mm, which, despite being below normal could be considered as satisfactory for land preparation, but inadequate for the crops already planted and for the pasture vegetation. Over the rest of the country, planting was either carried out under unfavorable conditions, or had to be postponed for July. Agroclimatic crop condition indices were mostly below the 30th percentile rank (on the scale from 0 to 100); monthly rainfall was mostly below 40 mm - well below the normal amounts (Table 2 and Figure 4). The only location with good agrometeorological conditions was Birni N'Konni.

July. The western half of the country was so dry that the potential for drought-induced food shortages this year became very real. The agroclimatic crop condition indices dropped to the 5-7th percentile rank in Niamey, Gaya and Tillabery, and the 14th percentile rank in Birni N'Konni. Monthly rainfall was below 50 percent of normal. Above normal temperatures (about 1°C) further agravated the conditions. The unfavorable weather impeded also the growth of pasture vegetation.

In the eastern half of the country the conditions were better, with Maradi, Magaria, Zinder and Maine Soroa receiving 108-155 mm of rainfall. These amounts could have led to a satisfactory yield this year if August rainfall had been around normal.

August. This is the most critical month of the crop growing season. Plants reach the flowering stage when the water requirements are at their peak. Over most of Niger, August weather this year was a real disaster: rainfall was at record low levels, air temperatures (about 3.5°C above normal) were at record high levels. Cumulative rainfall - from the beginning of the rainy season till the end of August - was also the lowest, or the second lowest in history. As a result, the state of all rainfed crops in the country worsened so much that complete crop failures in many areas became a reality. There was the potential for severe food shortages in the country. The drought also inhibited the growth and development of pasture vegetation.

Good indicators of the weather impact on crops (and pastures) are the agroclimatic crop condition indices. At the end of August they dropped as low as the 2-3rd percentile rank in Tillabery, Niamey, Gaya, Tahoua and Maine Soroa,

and to the 5th percentile rank at three other stations (Table 2). Such low ranks are usually associated with well below normal yields or complete crop failures.

The only station with good rainfall in August was Magaria with 200 mm (91 percent of normal).

September. September rainfall could be beneficial for some late planted crops, especially if the agrometeorological conditions earlier in the season were around normal. This year, however, the three preceding months (June, July and August) were so dry that even good September rainfall would have come too late to substantially improve their state. In fact, the first half of September 1984 was generally dry and by that time this year's crop prospects in the country were already determined. During the second half of September, above normal rainfall in Tillabery and Tahoua improved the general water supply and benefitted to some extent pastures.

June-September. This year's crop (and pasture) growing season was the driest or one of the driest in Niger's history. The drought affected the entire country. The only location where the drought effect was less pronounced was Magaria. The adverse drought effect is further magnified by the fact that this is the second or even the third severe drought in a row, as indicated by the percentile ranks of the Yield Moisture Index (Figures 5-7).

CROP YIELD ESTIMATE

There is no reliable research work on the quantitative relationship between weather and crop yields (or crop production) in Niger. In addition, no research has been carried out on the relationship between weather and pasture vegetation. An approximate estimate for the 1984 crop yields can be made by using the percent of normal values of the Yield Moisture Index. It is to a great extent proportional to crop yield, if all non-weather factors affecting yield (fertilizers, pests, diseases, social factors, etc.) are constant.

Obviously, the method cannot be applied for those locations where the 1984 crop yield was more or less a complete failure. It is assumed that such stations are Tillabery, Niamey and Tahoua, as explained earlier in this assessment (see also Table 2 and Figure 4). Furthermore, stations that are not in the crop growing areas - Maine Soroa and N'Guigmi - should be excluded. The result of all these conderations indicates that the 1984 millet and sorghum yields will be about 25-28 percent lower than those in 1983.

SATELLITE DATA ASSESSMENT

In addition to the assessment made on rainfall data, the existing conditions in a given area can be assessed also from satellite images. The latter determine the degree of biomass (greenness) on the ground. The more vegetation on the ground, the higher the degree of greenness. It is presented with the use of the vegetative index (Figure 8). Obviously, a higher index means higher degree of greenness, which in turn means healthier crops or pasture vegetation.

The data on Figure 8 were obtained with the help of the "Ambroziak Color Coordinate System". The agricultural areas of the country were divided into rectangles of 1° latitude and 2° longitude. The satellite images clearly illustrate the areas with different degrees of vegetation at the end of August 1984. Thus, the area around Tillabery is devoid of vegetation, while the area around Magaria looks relatively good; the area around Niamey has as much vegetation as the area south of N'Guigmi, despite the fact that Niamey normally has a much wetter climate.

A comparison between the degree of greenness in 1983 and 1984 indicates that at the end of August this year all agricultural areas of the country had less vegetation cover than during the same time last year. This is valid not only for the crop growing areas, but for the pastures as well. The amount of pasture vegetation in August this year is estimated to be about one half (or even less) than in August 1983.

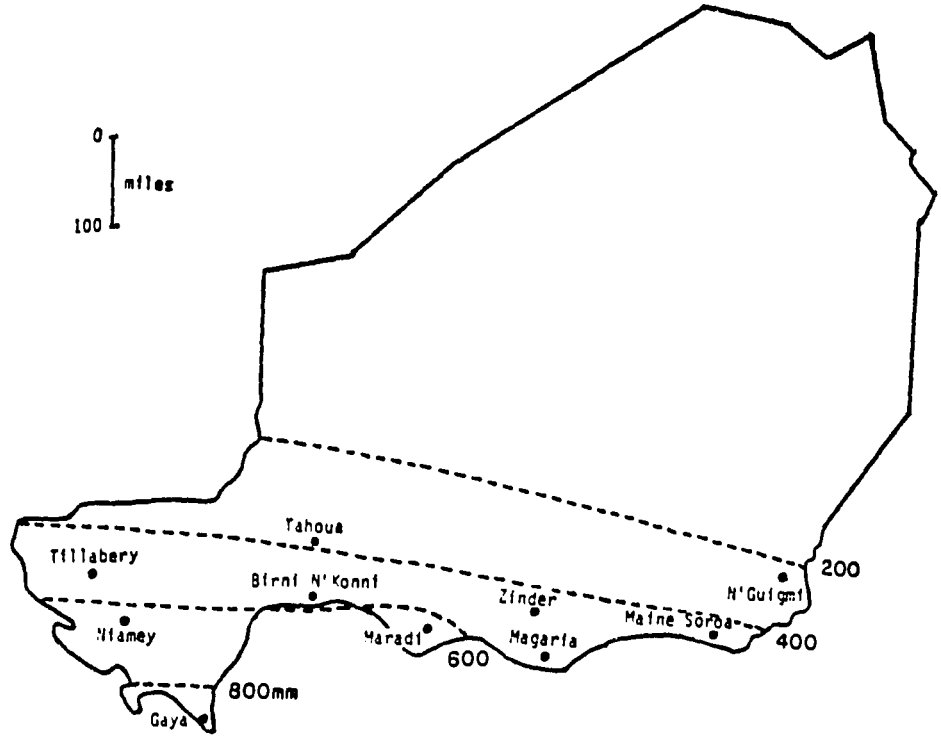


Figure 1. Niger: mean annual rainfall (mm) from the climatological Atlas of Africa (Jackson, 1961) and reporting meteorological stations.

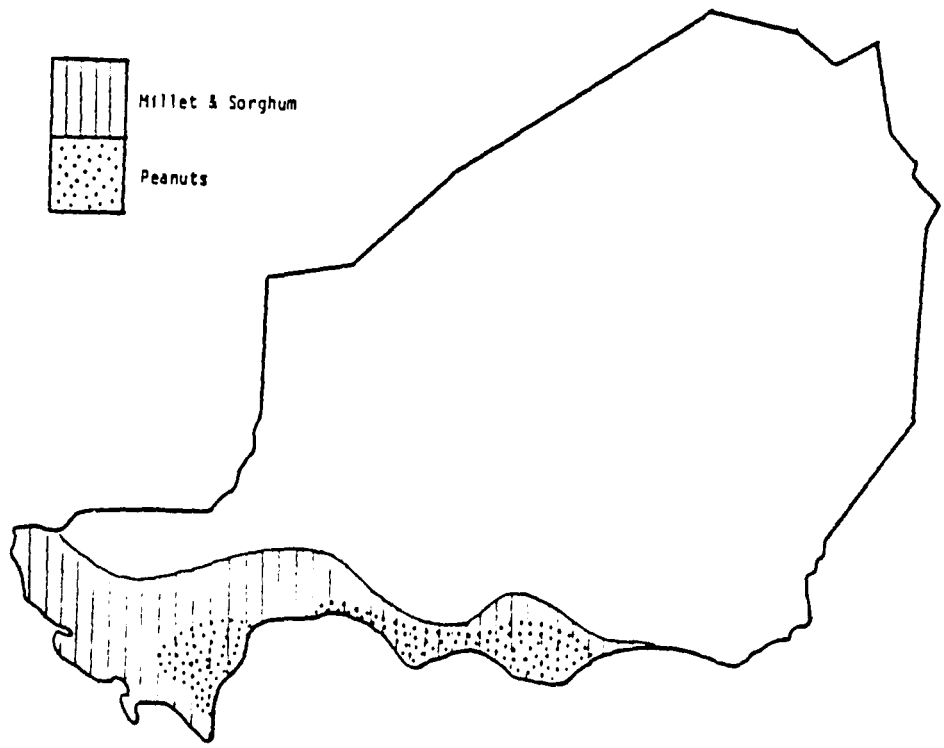


Figure 2. Niger: crop growing areas

Table 1. Mean annual rainfall (mm) in Niger

Station	Mean annual amount from various reference sources	Mean annual amount for the last 17 years (1968-1984)	Decrease during the last 17 years (in percent)
Tillabery	510	330	35
Niamey	636	498	22
Gaya	852	782	8
Birni N'Konni	602	455	24
Tahoua	407	330	19
Maradi	642	444	31
Magaria	617	494	20
Zinger	549	394	28
Maine Soroa	418	316	24
N'Guigmi	236	188	20

Table 2. Monthly and seasonal rainfall (in mm and percent of normal) and the percentile rank of the Yield Moisture Index from June 1, till the end of each month

Station	MAY		JUN			JUL			AUG			SEP			JUN-SEP	
	mm	%	mm	%	rank	mm	%	rank	mm	%	rank	mm	%	rank	mm	%
Tillabery	18	95	13	26	7	49	39	7	46	30	3	212	312	71	320	77
Niamey	53	139	41	54	14	63	37	5	57	30	2	43	47	2	204	36
Gaya	59	82	77	61	20	96	50	5	98	42	2	149	90	8	420	53
Birni N'Konni	53	151	110	162	85	41	29	14	80	42	5	77	83	11	308	58
Tahoua	14	78	40	70	32	77	66	20	46	33	2	71	116	17	234	60
Maradi	8	33	12	18	2	121	78	17	103	50	5	18	21	2	254	47
Magaria	17	61	42	69	32	127	72	29	200	91	35	22	24	15	391	68
Zinder	2	9	15	33	20	155	116	55	60	30	5	47	76	11	277	60
Maine Soroa	0	0	15	45	29	108	102	49	34	21	2	31	54	2	188	51
N'Guigmi	0	0	1	10	2	52	85	44	53	40	17	13	72	19	119	52

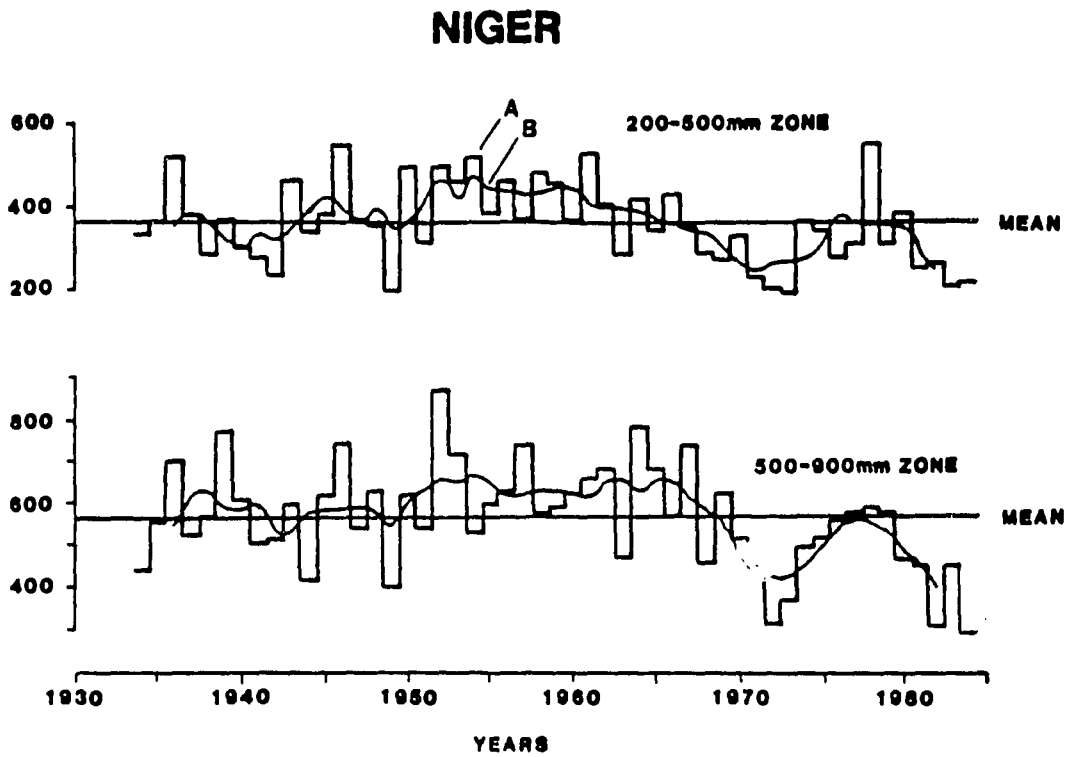


Figure 3. Niger: annual amounts of rainfall (A), the five year running average (B) and the mean annual rainfall for the period 1934-1984.

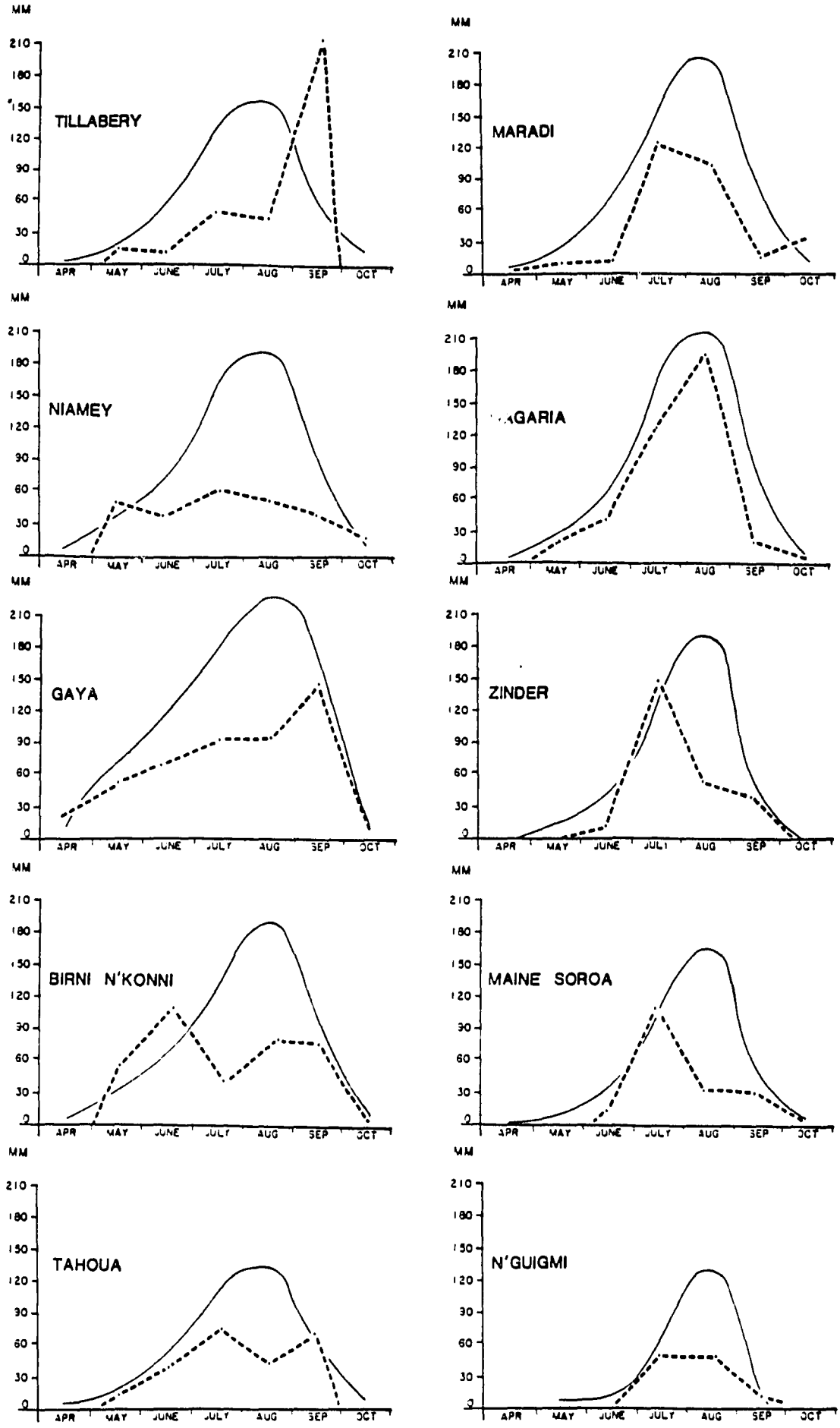
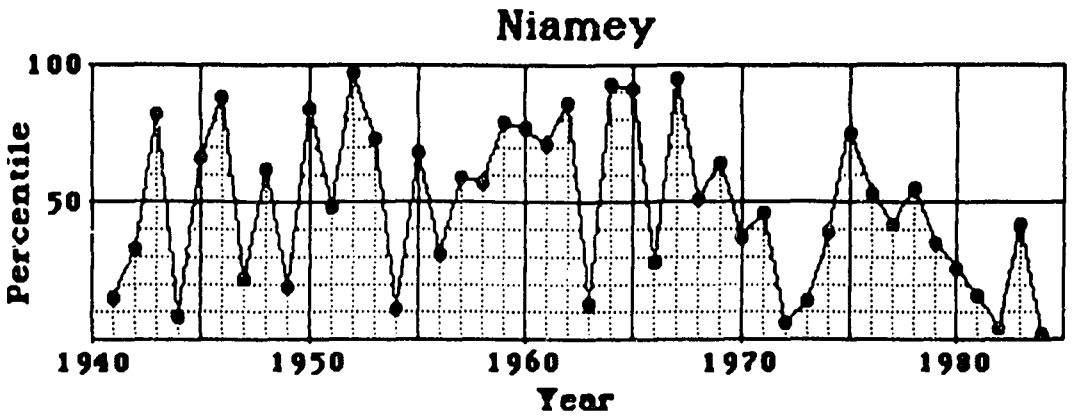
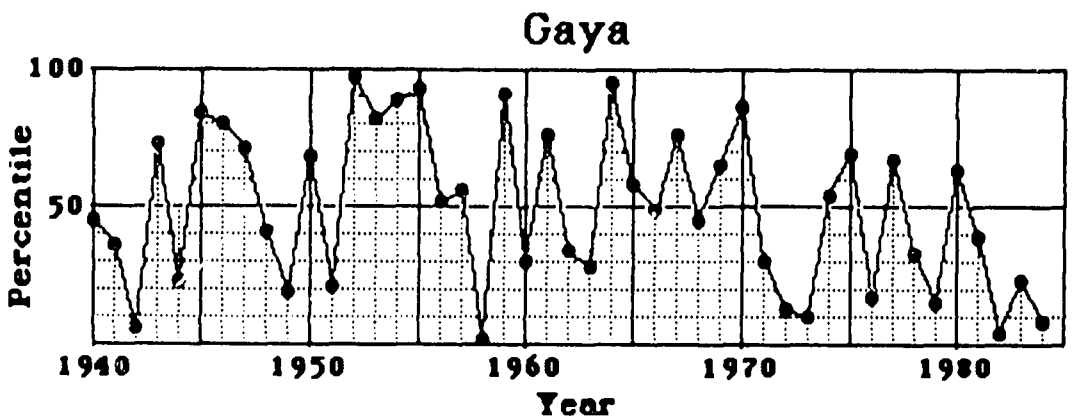


Figure 4. Mean monthly rainfall (continuous line) and monthly rainfall in 1984 (dotted line)

Figure 5.

NIGER: Percentile Ranks of the Yield Moisture Index as of the End of September





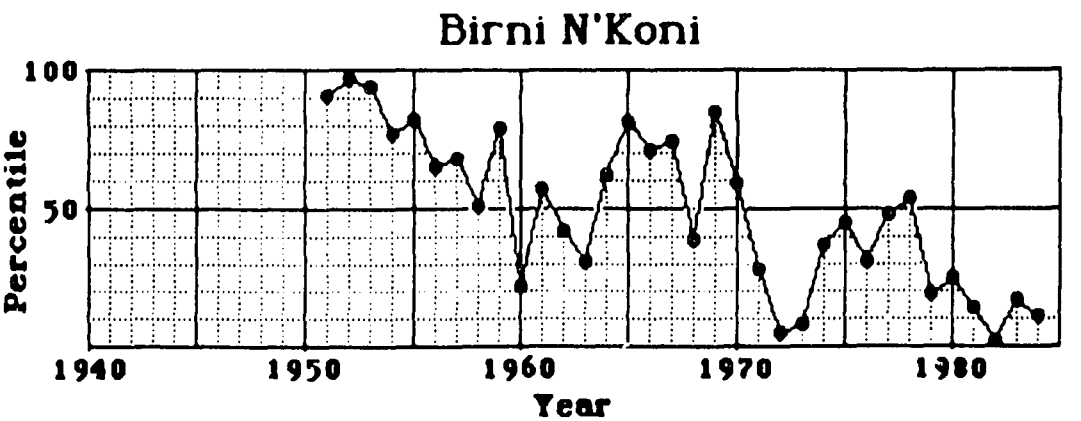
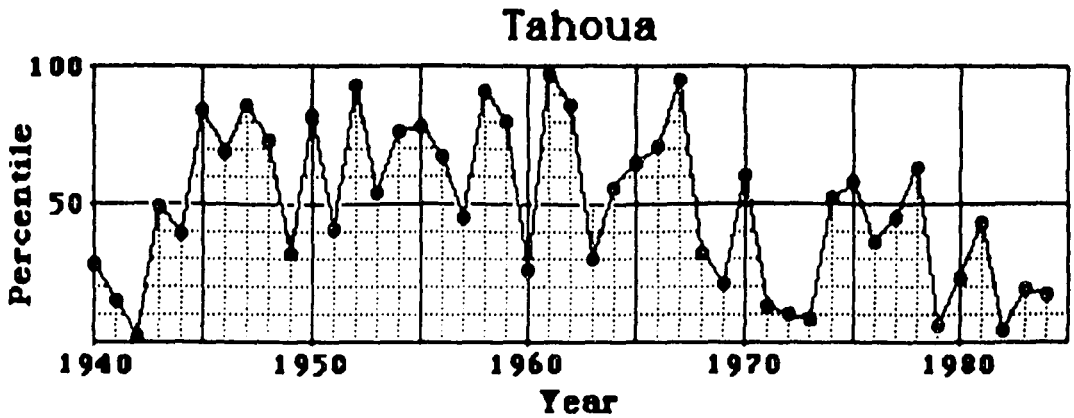
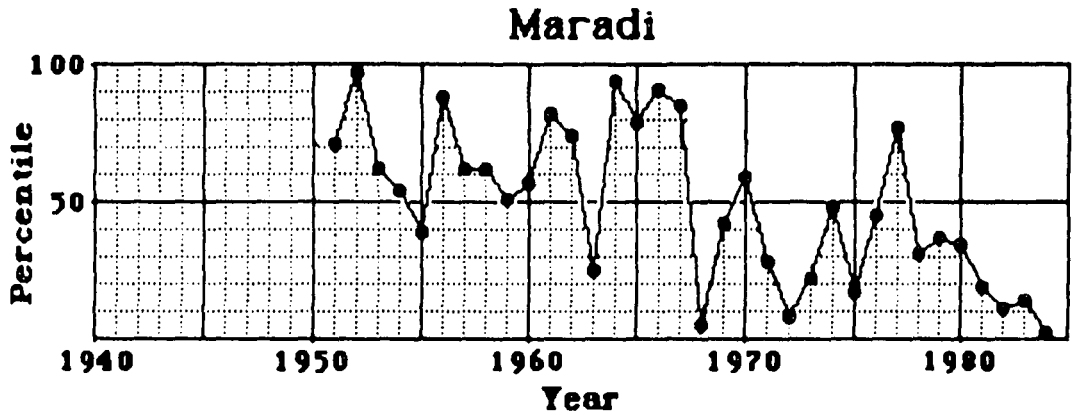


Figure 6.

NIGER: Percentile Ranks of the Yield Moisture Index as of the End of September





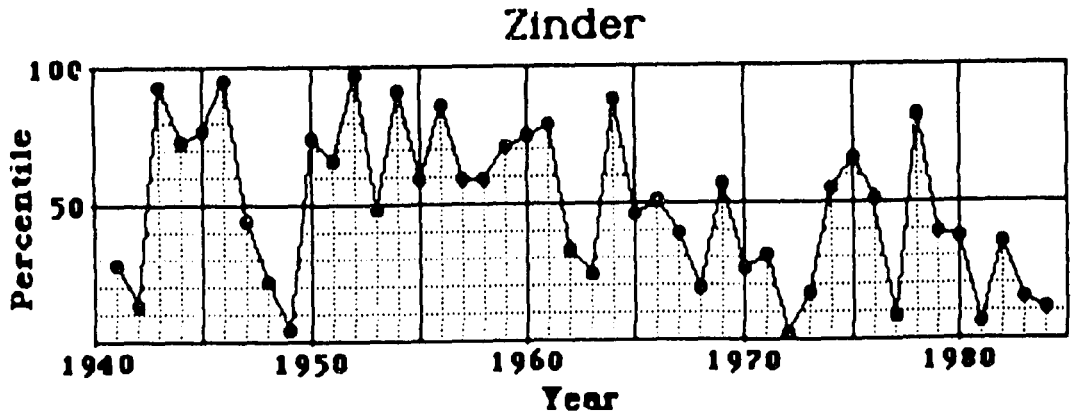
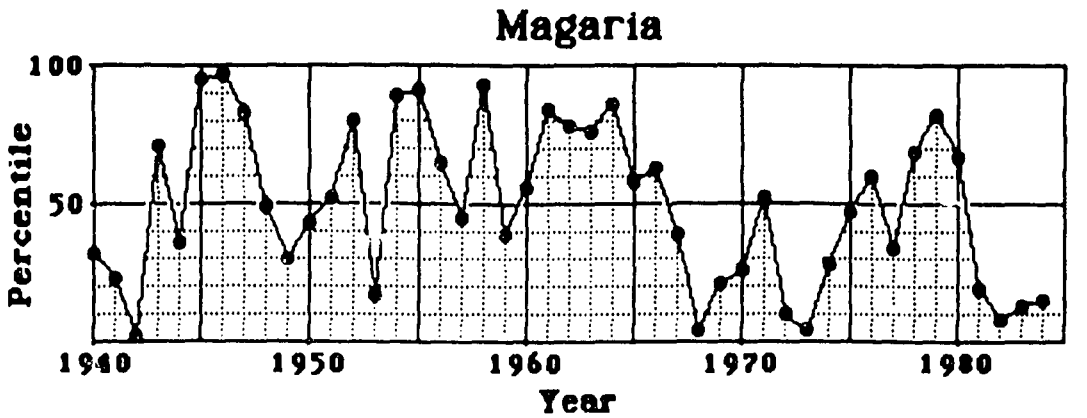
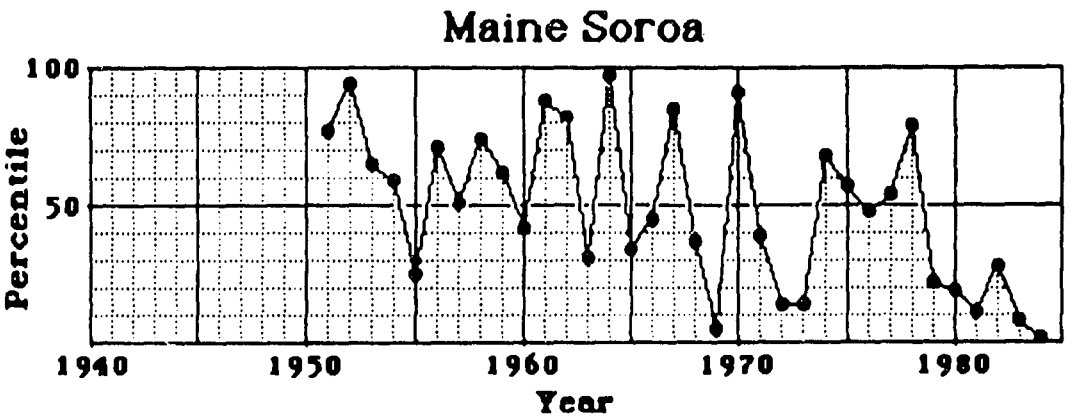


Figure 7.

NIGER: Percentile Ranks of the Yield Moisture Index as of the End of September





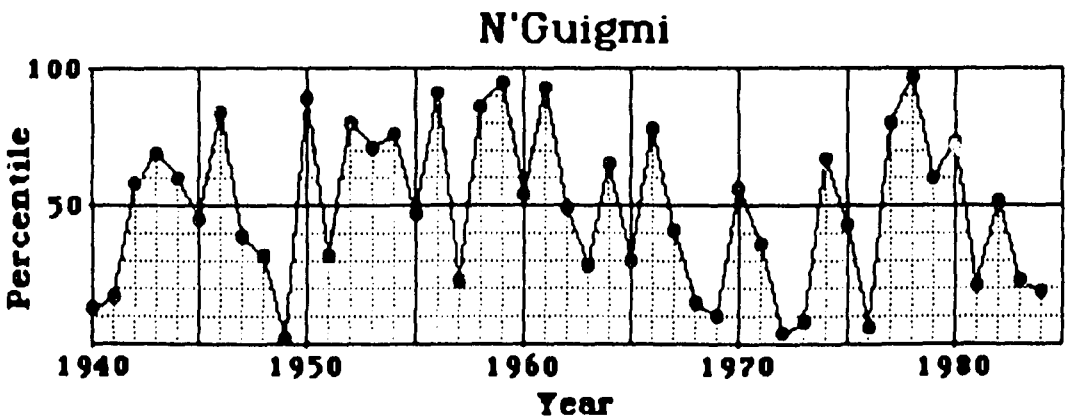
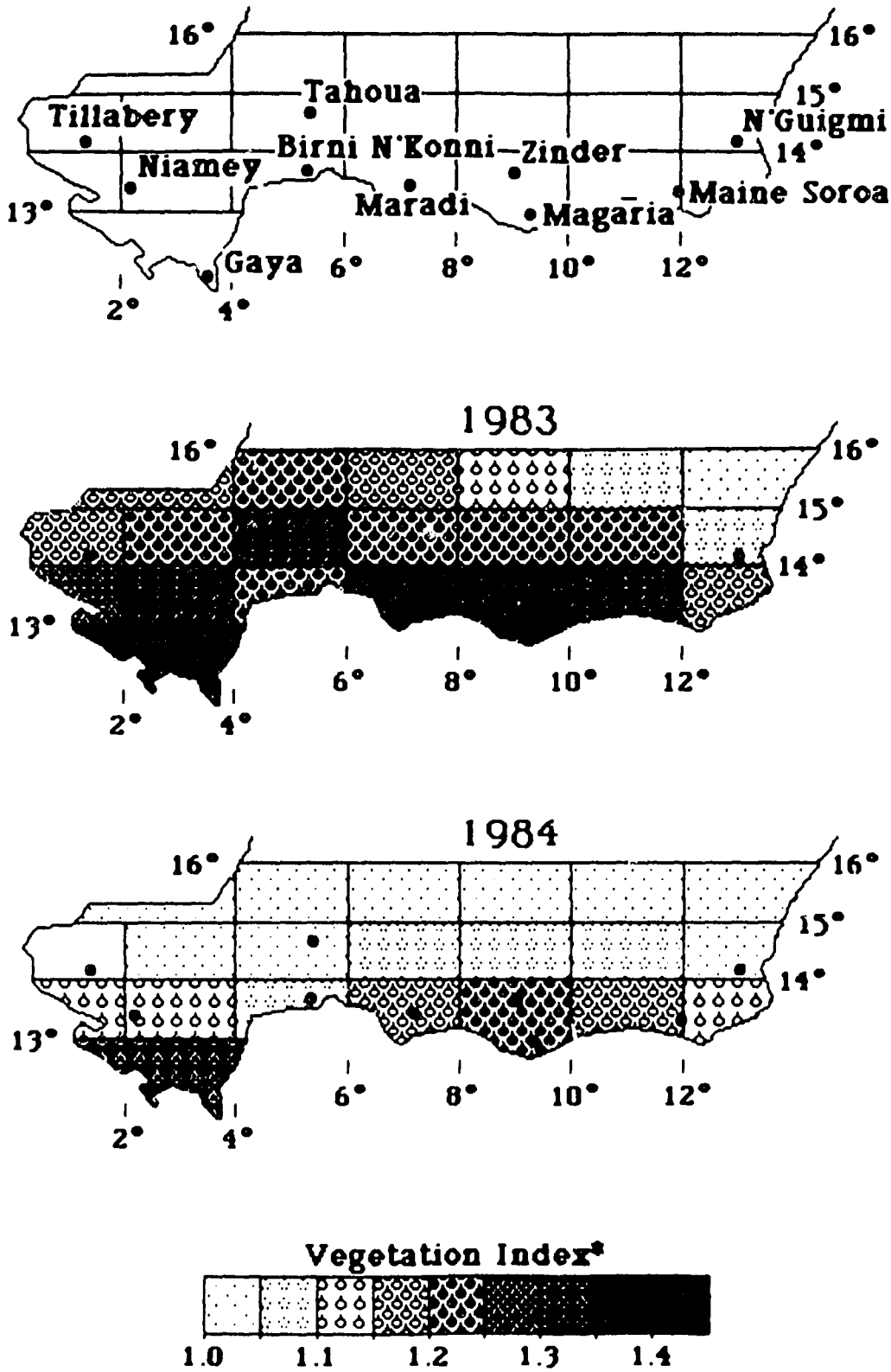


Figure 8.

Niger: Satellite Index Values as of the Last Week of August



* C_2 / C_1 where C is the channel count value.

MALI

SPECIAL AGROCLIMATIC ASSESSMENT OF THE 1984 SEASON

Prepared by the Climate Impact Assessment Division, Assessment and Information Services Center of NOAA - November 28, 1984

THE RAINFALL REGIME

The rainy season in Mali normally lasts about 3-4 months in the northernmost agricultural areas and about 5-6 months in the southernmost locations. In the south it normally begins in May and lasts until October, while in the north the rainy season begins about 1-2 months later and ceases a month earlier. Because of the water availability this is also the crop growing season. The rest of the year is generally dry. Therefore rainfall amounts during the rainy season are the same (with few minor exceptions) as annual amounts. In Mali, like in all other Sahel countries, the annual rainfall amount increases from north to south (Figure 1).

THE AGRICULTURAL CROPS

The northern limit of rainfed farming in the Sahel is considered to be the 350 mm annual rainfall isohyet. Of certain agricultural importance are the pastures north of the 350 mm line to about the 200-220 mm isohyet.

Sorghum and millet are grown all over the country. Being the most drought resistant food crops, they are more or less the only crops grown from the 350 mm to about the 500 mm zone. Maize and peanuts are usually grown south of the 500-550 mm isohyet. A wider variety of food crops (including some tubers), plus some commercial crops, are grown in the wetter areas in the south. In addition to the rainfed farming, some irrigated crops - mostly rice, vegetables and fruits - are also grown along the rivers.

THE CHANGING CLIMATE

The drought of 1984 is not an isolated phenomenon. Rainfall amounts in Mali began a decline around 1968 that has continued to the present. The annual rainfall during the last 50 years (1934-1983) in Mali was analyzed on a zonal basis. Three main zones were designated: 200-500 mm, 500-900 mm and 900-1,300 mm. The zonal rainfall for each year is shown on Figure 2. Also indicated are the mean values for the 50 year period and the 5 year running averages. The decline is well pronounced in all three zones. The figures also illustrate the severity of the drought in 1983.

Sixteen consecutive dry years is a long enough period to affect both natural vegetation - some of it irreversably - and the agricultural practice. It is also long enough to make obsolete the rainfall normals calculated for periods before the decline began. Shown on Table 1 are the mean annual amounts from various reference sources (calculated for periods before 1968 and still widely used in and outside Africa) and the mean amounts for the last 16 years. The discrepancy is obvious. Mean rainfall for the period after 1968 is mostly 20-30 percent lower than the mean ranfall for the period before 1968.

The mean annual rainfall shown on Figure 1 represents the old normals. If a new map for the 1968-1983 mean annual rainfall in Mali were to be prepared, all those isohyets on Figure 1 would have to be moved southwards by about 50-60 miles.

Besides the differences in the mean amounts of rainfall, the changing climate of the country has affected all other components of what is called "rainfall regime," such as number of rainy days, beginning and end of the rainy season, various confidence limits of rainfall (amounts that have certain probability of occurrence), etc. The success or failure of a crop in many areas depends not only on the amount of rainfall, but also on the duration of the rainy season. A good example of its shortening can be found in Nioro, where the dates of crossing the 40, 60 and 80 mm thresholds are given on Figure 3. At any of these thresholds, the rainy season for the last 16 years begins later (an average of 14-21 days) and ends earlier (6-8 days), therefore lasting 22-27 days less.

AGROMETEOROLOGICAL ASSESSMENT OF THE 1984 SEASON

May. In most southern areas of the country the rainy season began on time, with normal or above normal rainfall (Table 2).

June. Below normal rainfall over most of Mali adversely affected the timely sowing of crops. Nevertheless, by the end of the month the areas south of the Kayes-Segou line (Figure 4) received more or less adequate rainfall (70-140 mm) for land preparation and sowing. In the areas where the rainy season begins in June, the agroclimatic crop condition indices at the end of the month were mostly below the 30th percentile ranks (on the scale from 0 to 100). Segou and Kayes were the only stations reporting normal or above normal rainfall and, as a result, the indices were above the 50th percentile rank.

July. Unusually dry and hot weather (about 2°C above normal temperatures) sharply increased the possibility for below normal yields and food shortages in the country. In many locations in the central belt of the country (Kayes, Kita, Bamako, Koutiala, San) rainfall of 70-110 mm was well below the optimal crop water requirements and as a result the agroclimatic indices at the end of the month dropped to the 2-4 percentile rank, indicating severe drought - one of the most devastating on record. Kayes' index was at the 36 percentile rank due to good rainfall in June (at the end of June, however, it was as high as the 93 percentile rank). In the arid northeast of Mali (Hombori, Gao, Menaka) July rainfall was inadequate not only for sowing crops, but also for normal growth of pasture vegetation. Agroclimatic indices at the end of the month were also at record low levels. The only area of Mali where the agroclimatic conditions in July could be assessed as satisfactory was the far south of the country (Kenieba, Bougouni, Sikasso) where rainfall amounts, although only 70-80 percent of normal, ranged mostly between 170 and 200 mm, which is sufficient to carry a satisfactory yield.

August. This is the most critical month of the crop growing season. Plants reach the flowering stage when the water requirements are at their peak. Extremely dry and hot weather this year further aggravated the state of agricultural crops. It became evident at the end of the month that the 1984 crop production would be one of the lowest on record. Most affected by the drought were the semi-arid northern agricultural areas of the country (Figure 5), where rainfall in August, as well as from the beginning of the season till the end of August, was so low that this year's crops were expected to be either a complete failure or to yield very little. Agroclimatic indices were below the

5th percentile rank, indicating the worst, or the second worst drought on record. Such percentile ranks in marginal areas are usually associated with complete crop failures.

Second most affected area was near Burkina's border (Mopti, San, Koutiala, Segou). Agroclimatic indices were also below the 6th percentile rank, but seasonal rainfall, although only 50-70 percent of normal, was slightly higher than in the northern areas. Yields are expected to be well below normal; complete crop failures are possible in some locations. June through August rainfall in this part of the country ranged between 210-240 mm in Mopti and San, and 300-350 mm in Koutiala and Segou. Monthly air temperatures were 2-4°C above normal.

Severe drought affected also the southwestern agricultural areas of the country. Agroclimatic indices at the end of August were at the 4-11 percentile rank, which for the more humid climate of this area suggests below to well below normal yields. Although monthly rainfall in June, July and August was below the normals, amounts of 110-200 mm in July and 140-250 mm in August were higher than in the rest of Mali and, therefore, crop losses in the Southwest are expected to be relatively smaller.

September. This is the last month of the crop growing season in the northern and central agricultural areas of the country; only in the south it ends in October. Several stations received good, above normal rainfall (Nioro, Nara, Mopti, Gao) but it came too late to significantly improve the state of the crops. In the rest of the country, September rainfall was below normal, further aggravating crop production prospects.

June-September. Nationwide, the 1984 crop growing season in Mali was extremely poor. Agroclimatic indices for the June-September period were at the 2nd or 3rd percentile rank in Kita, Bamako, San, Hombori and Menaka, indicating the worst drought on record (or at least after 1941 when calculation of the indices began). Kenieba and Bougouni had indices at the 4th percentile rank, indicating the second worst drought on record. Sikasso experienced its third worst drought on record. Not much better were the conditions in the rest of the country. The adverse drought effect is further magnified by the fact that this is the second (or third in some areas) severe drought in a row. The country was hit by a severe drought in 1983. At most stations the 1984 season was even drier: in San and Koutiala by about 250-270 mm, Bougouni - 170 mm, Mopti and Hombori by 130-140 mm, Kita and Bamako by about 60 mm, etc. The only station with above normal rainfall this year was Tombouctou, where rainfall benefited pastures; unfortunately this is not a crop growing region.

The 1984 drought impact on sorghum and millet can also be assessed from the information provided on Figures 6 and 7. Plotted are the percentile ranks and the percent of normal values of the seasonal (June-September) Yield Moisture Index for the last 43 years. The agricultural areas of the country were divided into two main regions. The northern one is drier and is represented by seven stations with mean annual rainfall between 350 and 700 mm (Kayes, Nioro, Nara, Segou, San, Mopti and Hombori). The southern region is more humid and is represented by five stations with mean annual rainfall ranging between 900 and 1,200 mm (Kenieba, Bamako, Bougouni, Sikasso and Koutiala). The YMI plots permit the following conclusions:

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A. Northern region. The 1984 drought was the second worst on record, the worst being 1982. The third worst is 1983, thus indicating the highly unusual phenomenom of having the three worst years on record to be three consecutive years. The 1982-84 drought is more severe than the well known drought of 1972-73.

B. Southern region. The 1984 drought was the worst on record. The previous year (1983) was also extremely dry (third worst). The 1983-84 drought was more severe than the drought in 1972-73.

CROP YIELD ESTIMATE

There is no reliable research work on the quantitative relationship between weather and crop yields (or crop production) in Mali. An estimate for the 1984 crop yields can therefore be made by using the percent of normal values of the Yield Moisture Index. It is to great extent proportional to crop yield, if all non-weather variables affecting yield (fertilizers, pests, diseases, social factors, etc.) are constant.

In 1984 the regional YMI in the southern region was only 63 percent of normal, indicating that the drought alone is expected to drop crop yields to approximately 60-65 percent of their normal amounts for the various crops. In the drier northern region of Mali three stations (Nioro, Nara and Hombori) have complete crop failure in their vicinity. The percent of normal YMI for the remaining stations is as follows: Kayes - 85, Segou - 69, San - 55 and Mopti - 68. After some corrections for uneven rainfall distribution are made, the crop yields for the entire northern region in 1984 are expected to be about 30-35 percent of normal. Thus, an average value of the crop yield (and crop production) estimates for both regions in Mali indicates that the 1984 yields for the entire country are expected to be about 45-50 percent of normal.

SATELLITE DATA ASSESSMENT

Use of Satellite data for monitoring the status of vegetation provides a qualitative distribution of vegetative vigor which can be combined with other data to produce quantitative analyses. The index plots provide a time series plot which can describe an entire season for a specific area. The shape of the curve gives information about the phenology and biomass production of the plants in the sample. The color images are viewed using several different color coordinate systems. The coordinate system chosen depends on the area being examined, time of year, and vigor of the vegetation. The standard operational color coordinate system is the Ambroziak Color Coordinate System (ACCS). Other systems are the ACCS-2b and the ACCS-2r which have higher perceptual resolution than the ACCS and use either blue (b) or red (r) for the zero index value.

The analysis for Mali shows the eastern sections to be worse this year than last year (Figure 8). An attempt to quantify the rainfall using the ACCS images shows close agreement for most of the stations for the May through July rainfall (Figures 9 and 10). Kita reported 573 mm for 1983 which did not agree with the image and the amount was ignored in the analysis. The analysis was done for a special Sahel report and was prepared in mid-July. Later reports obtained in country showed that this amount was in fact in error by 200 mm and was actually 373 mm, which is what the original analysis showed. This illustrates a second use of the image. Not only can the images be used to interpolate station reports, they can be used for quality control.

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Since both 1983 and 1984 were severe drought years in Mali the comparison only serves to show drought patterns. Any region showing less than 400 mm on the June through September analysis has the potential for serious crop losses. This corresponds roughly to a vegetation index value of 1.4 or less in late September.

Table 1. Mean annual rainfall (mm) in Mali

Station	Mean annual amount from various reference sources	Mean annual amount for the last 16 years (1968-1983)	Decrease during the last 16 years (in percent)
Kayes	821	577	30
Nioro	709	412	42
Mopti	552	458	17
Hombori	454	353	22
Gao	271	200	26
Menaka	263	202	23
Tombouctou	225	147	35
San	749	683	9
Segou	724	590	19
Bamako	1,099	869	21
Kita	1,151	882	23
Kenieba	1,408	1,083	23
Bougouni	1,337	1,082	19
Koutiala	1,022	859	16
Sikasso	1,373	1,144	17

Table 2. Monthly and seasonal rainfall (in mm and percent of normal) and percentile rank of the Yield Moisture Index from June 1, till the end of each month

Station	MAY			JUN			JUL			AUG			SEP			JUN-SEP	
	mm	%	rank	mm	%	rank	mm	%	rank	mm	%	rank	mm	%	rank	mm	%
Kayes	10	71	-	170	198	93	88	51	36	160	70	20	127	82	20	545	85
Nioro	2	22	-	19	36	13	91	63	11	36	18	4	153	142	22	299	60
Nara	10	100	-	20	45	17	75	61	11	74	44	5	100	118	17	269	64
Mopti	0	0	-	9	15	2	131	94	22	74	44	6	102	111	15	316	68
Hombori	24	240	-	7	16	2	40	33	2	24	16	2	57	88	2	128	34
Gao	3	43	-	0	0	2	36	52	6	24	25	2	50	156	15	109	49
Menaka	25	357	-	4	17	11	7	9	2	32	30	2	14	35	2	57	22
Tombouctou	14	467	-	52	400	90	128	312	95	29	47	81	10	40	68	219	118
San	36	84	-	49	52	9	69	38	2	124	51	2	111	86	2	353	55
Segou	106	392	-	83	102	52	150	81	34	116	52	2	75	61	9	424	69
Bamako	117	249	-	73	57	9	116	48	4	200	72	4	130	71	2	519	63
Kita	45	98	-	66	45	30	108	49	3	254	90	11	51	24	3	479	51
Kenieba	75	150	-	138	83	31	206	80	24	189	49	7	132	47	4	665	61
Bougouni	91	90	-	111	75	22	191	72	15	142	45	6	165	77	4	609	64
Koutiala	58	84	-	70	51	4	93	42	2	140	49	6	149	83	10	452	55
Sikasso	122	115	-	104	69	9	171	67	11	243	76	6	168	79	6	686	73

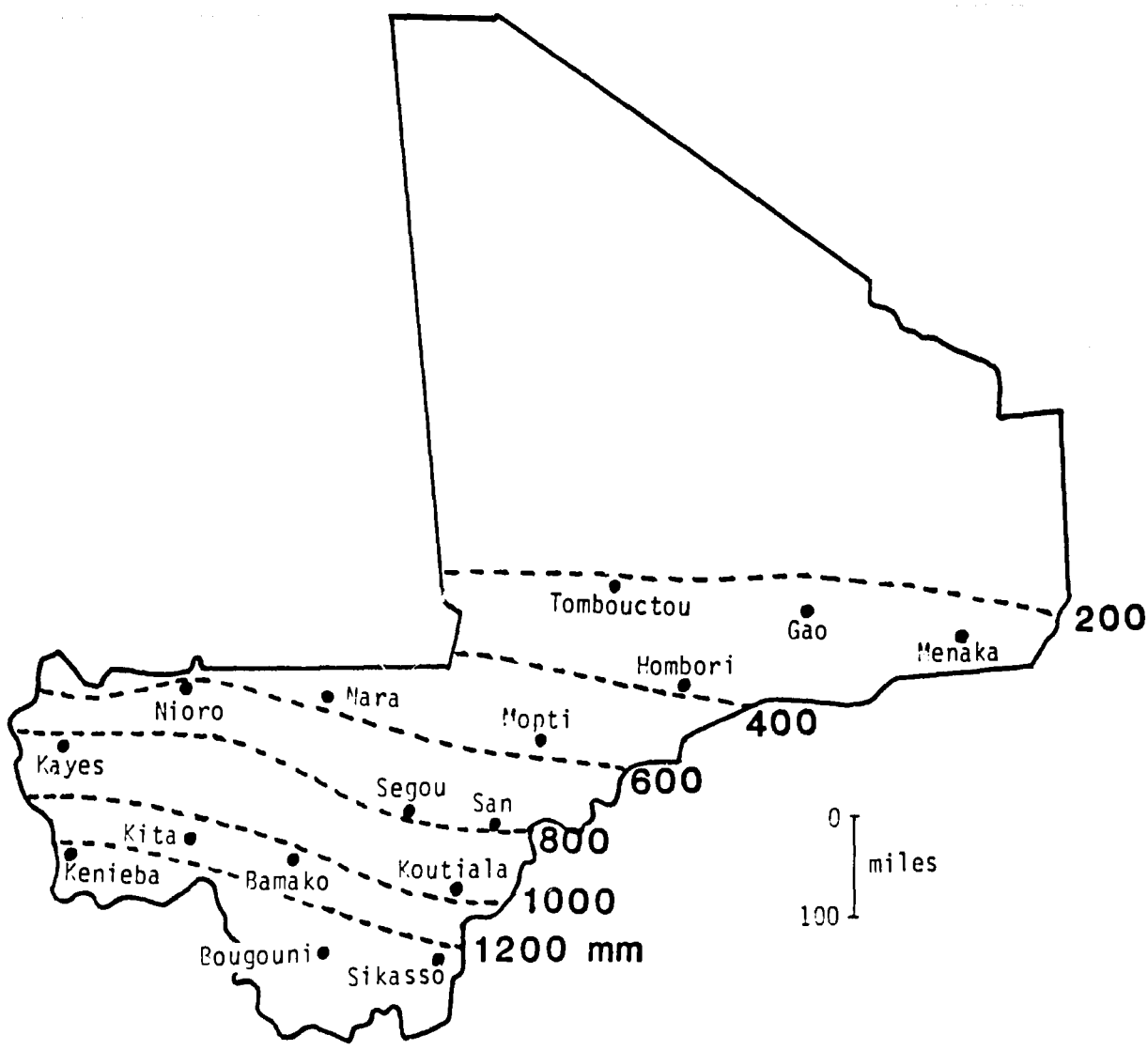


Figure 1. Mali: mean annual rainfall (mm) from the Climatological Atlas of Africa (Jackson, 1961) and reporting meteorological stations

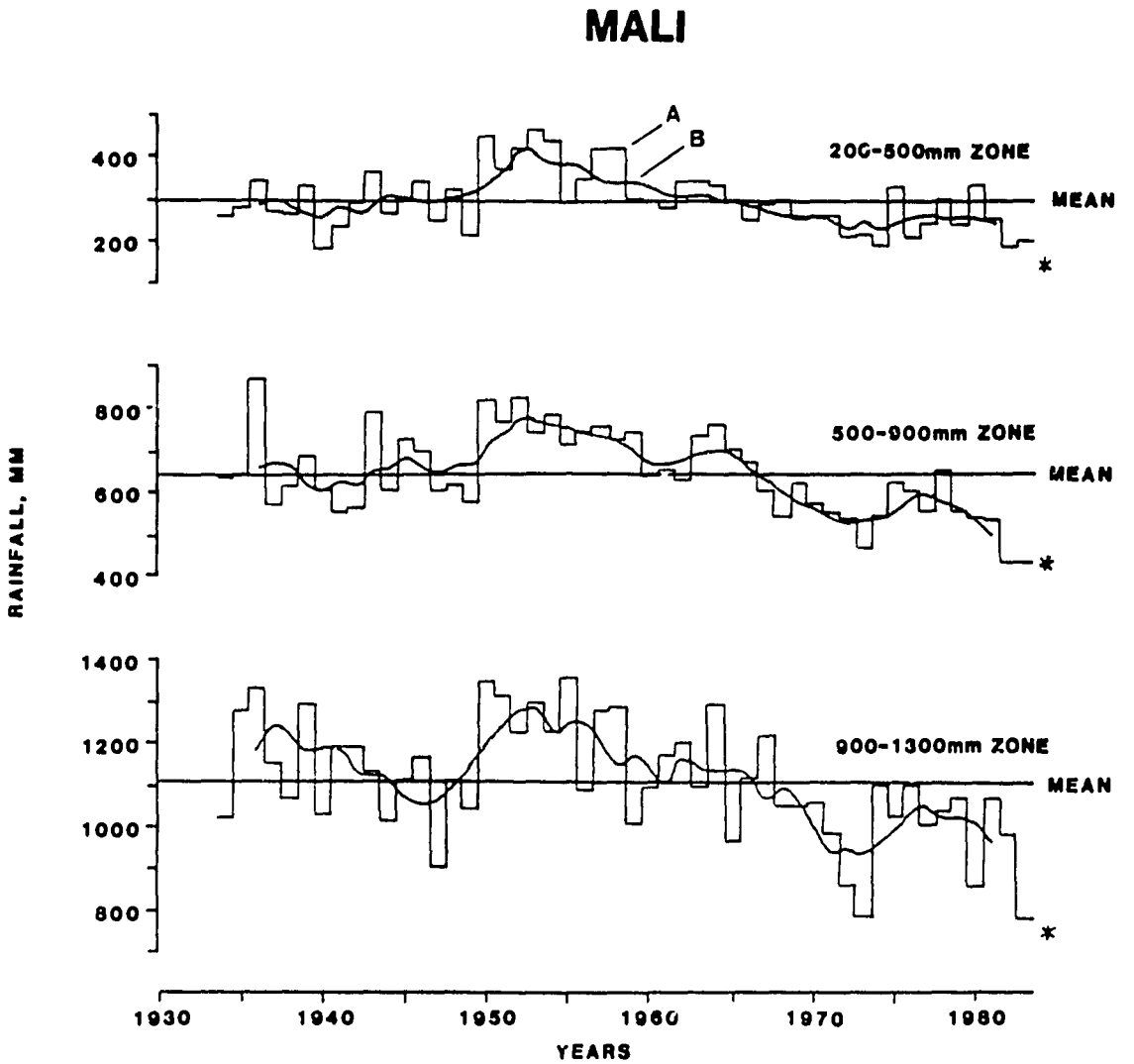


Figure 2. Mali: annual amounts of rainfall (A), the five year running average (B) and the mean annual rainfall for the last 50 years (1934-83)

Rainfall amounts through October 1984 are marked with *

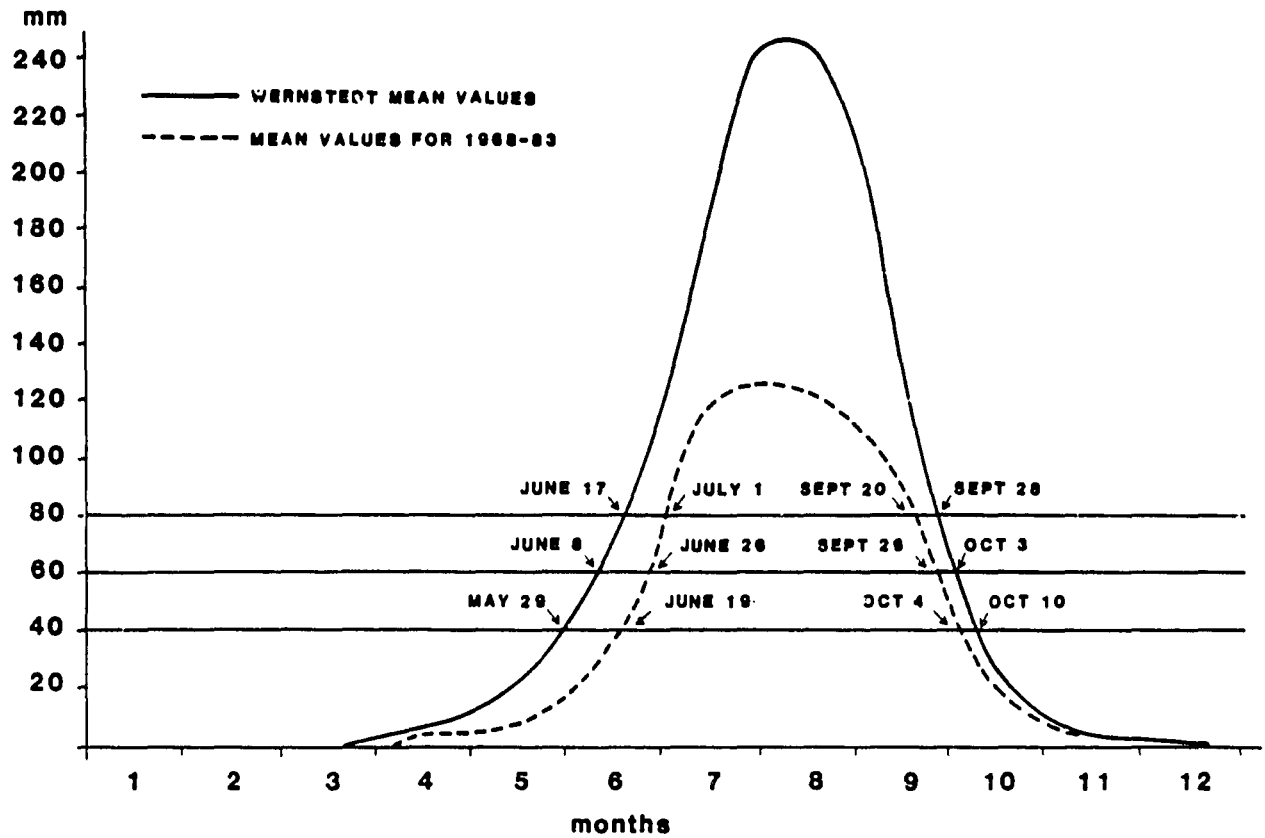


Figure 3. Nioro, Mali: mean monthly rainfall from a reference source (Wernstedt, 1972) and for the last 16 years (1968-83); beginning and end of the rainy season

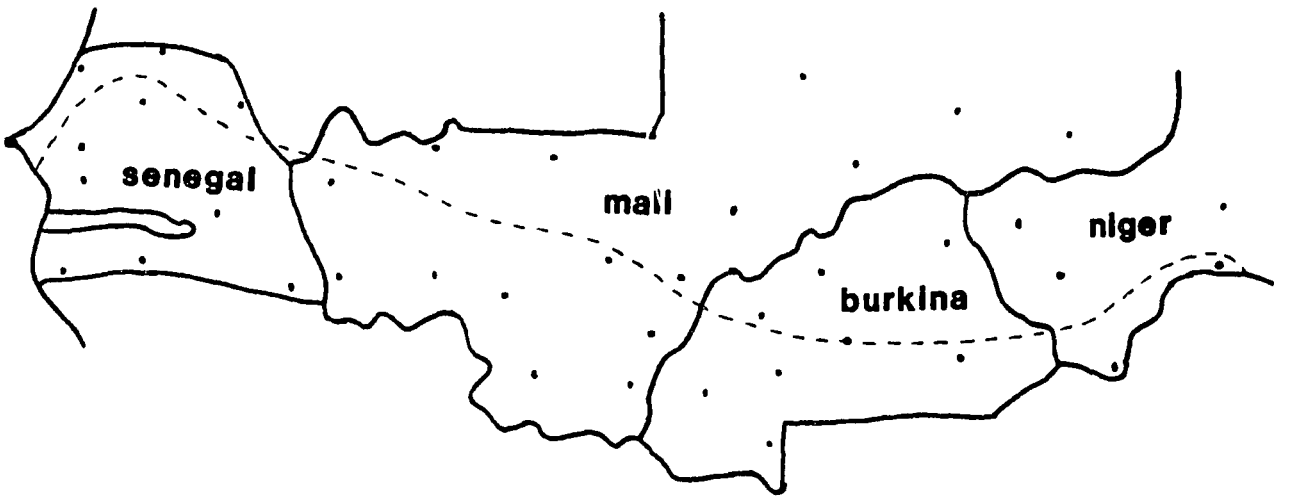


Figure 4. Northward advance of planting in the Sahel. Rainfall below the dotted line was adequate through June 1984 for sowing agricultural crops (individual dots indicate locations of reporting station; see Fig. 1)

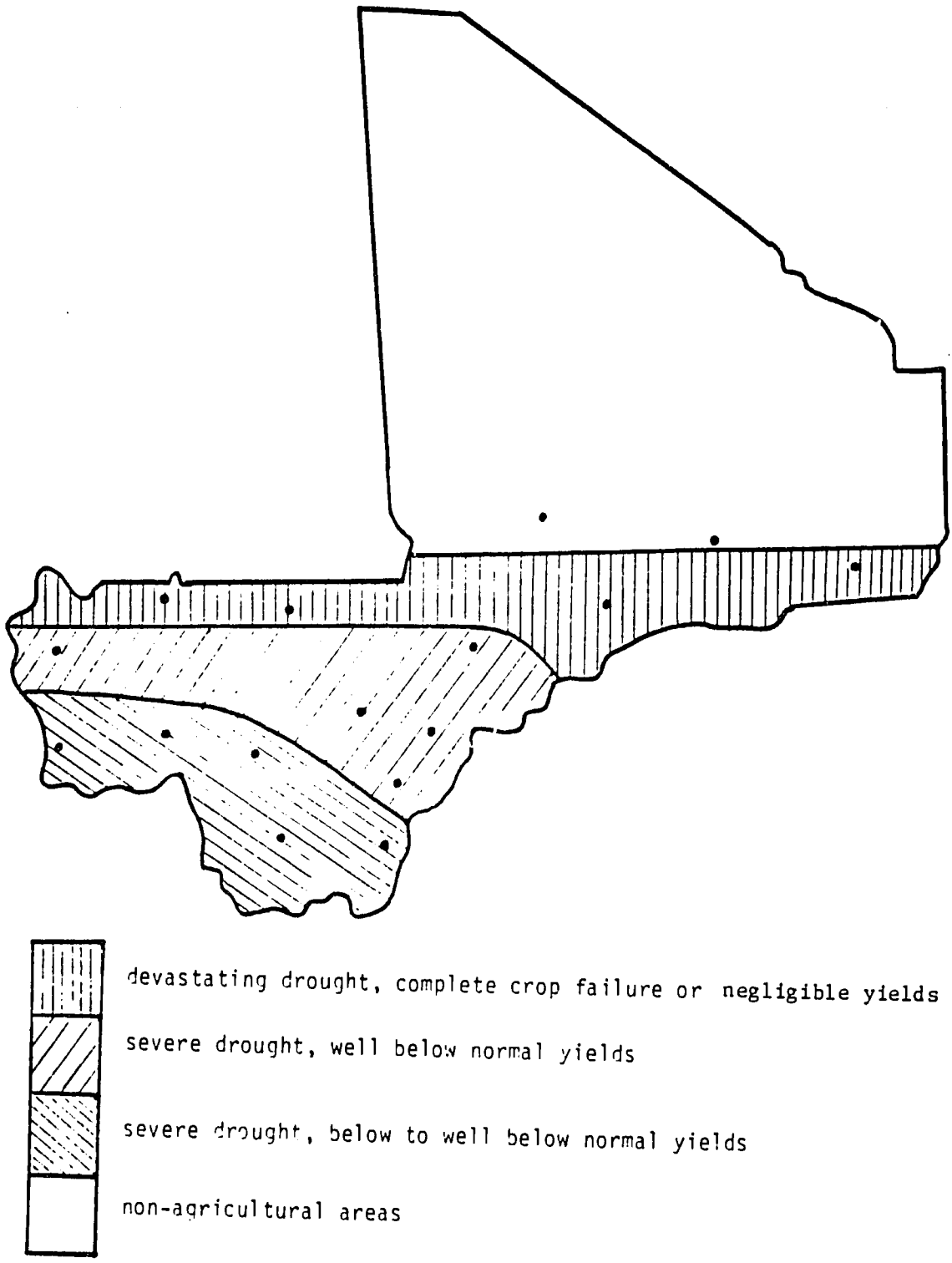
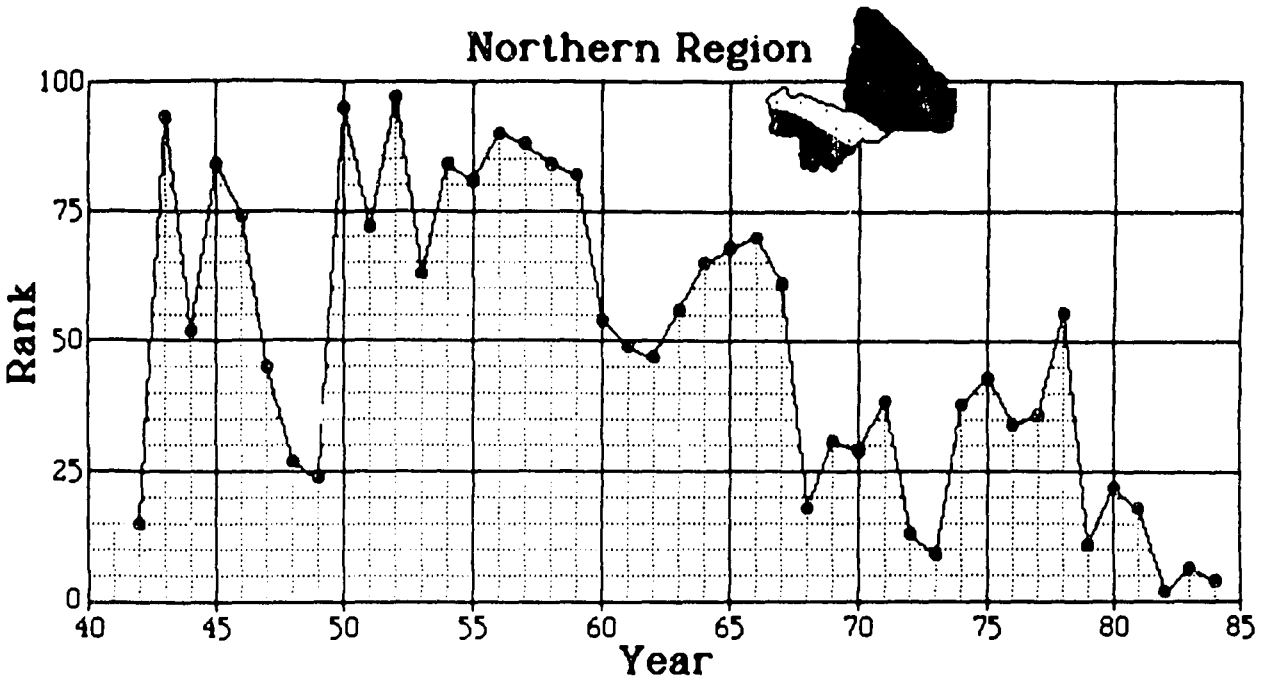


Figure 5. Mali: drought impact in 1984

Figure 6. **MALI**

YMI Percentile Ranks as of the End of September



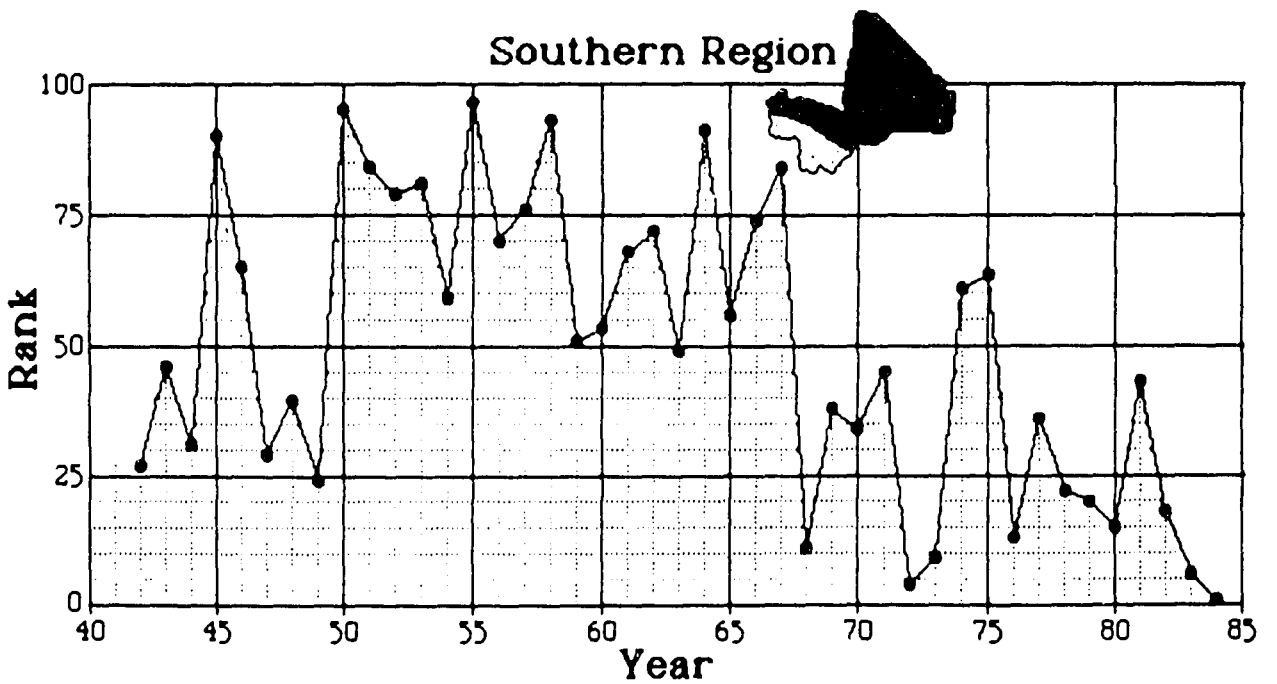
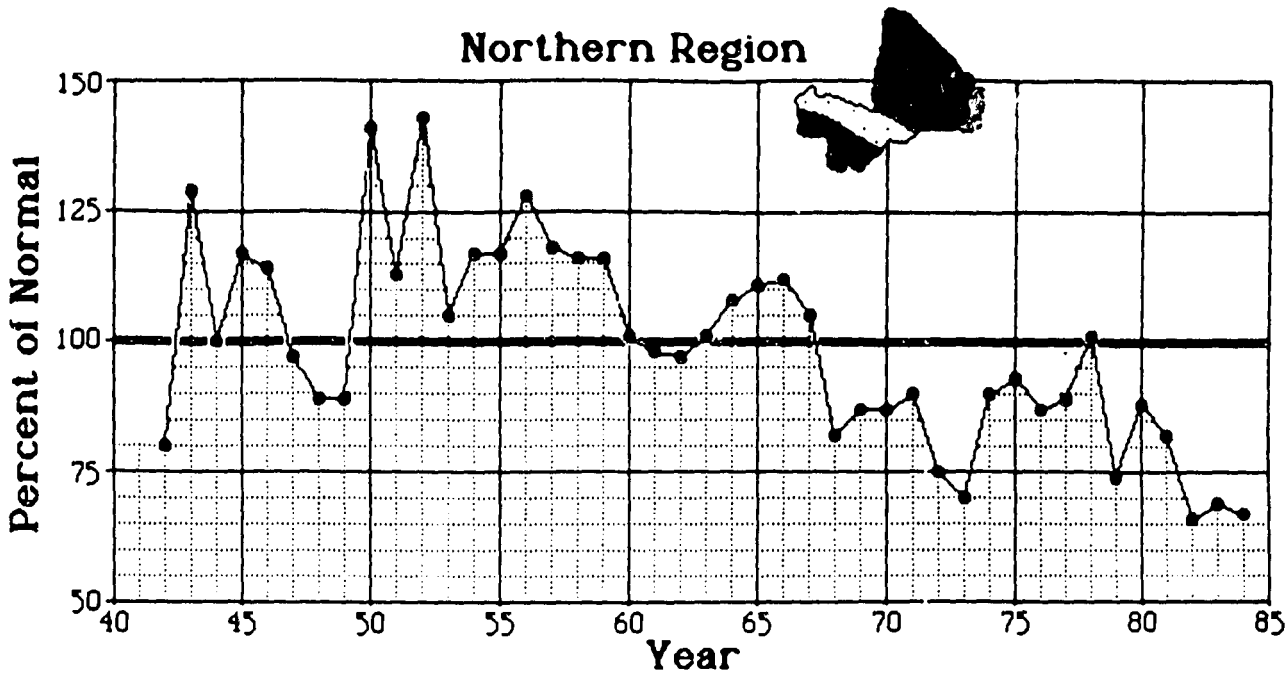
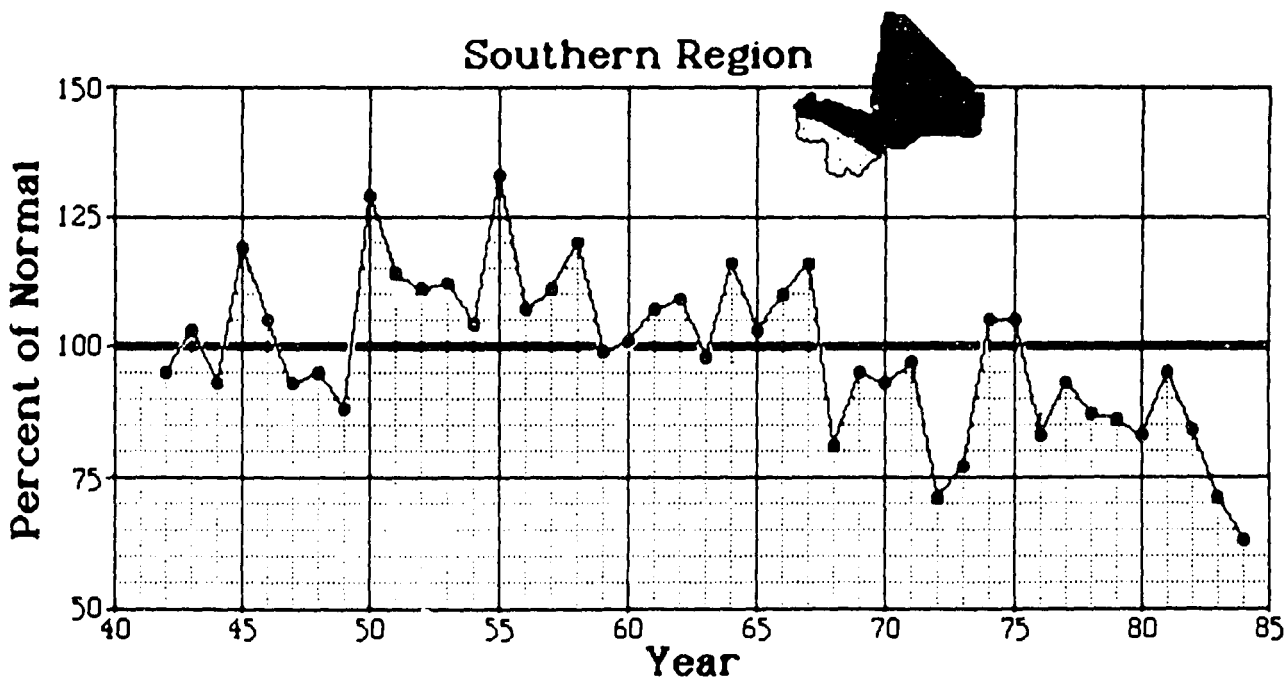


Figure 7.

MALI

YMI Percent of Normal as of the End of September





YMI percent of normal in the African Sahel is proportional to crop production if all non climate variables affecting production are constant and the total seasonal rainfall exceeds 500 mm. In any region in which seasonal rainfall is less than 350 mm production is zero.

Figure 8

MALI: Vegetation Index from NOAA AVHRR Satellite Data

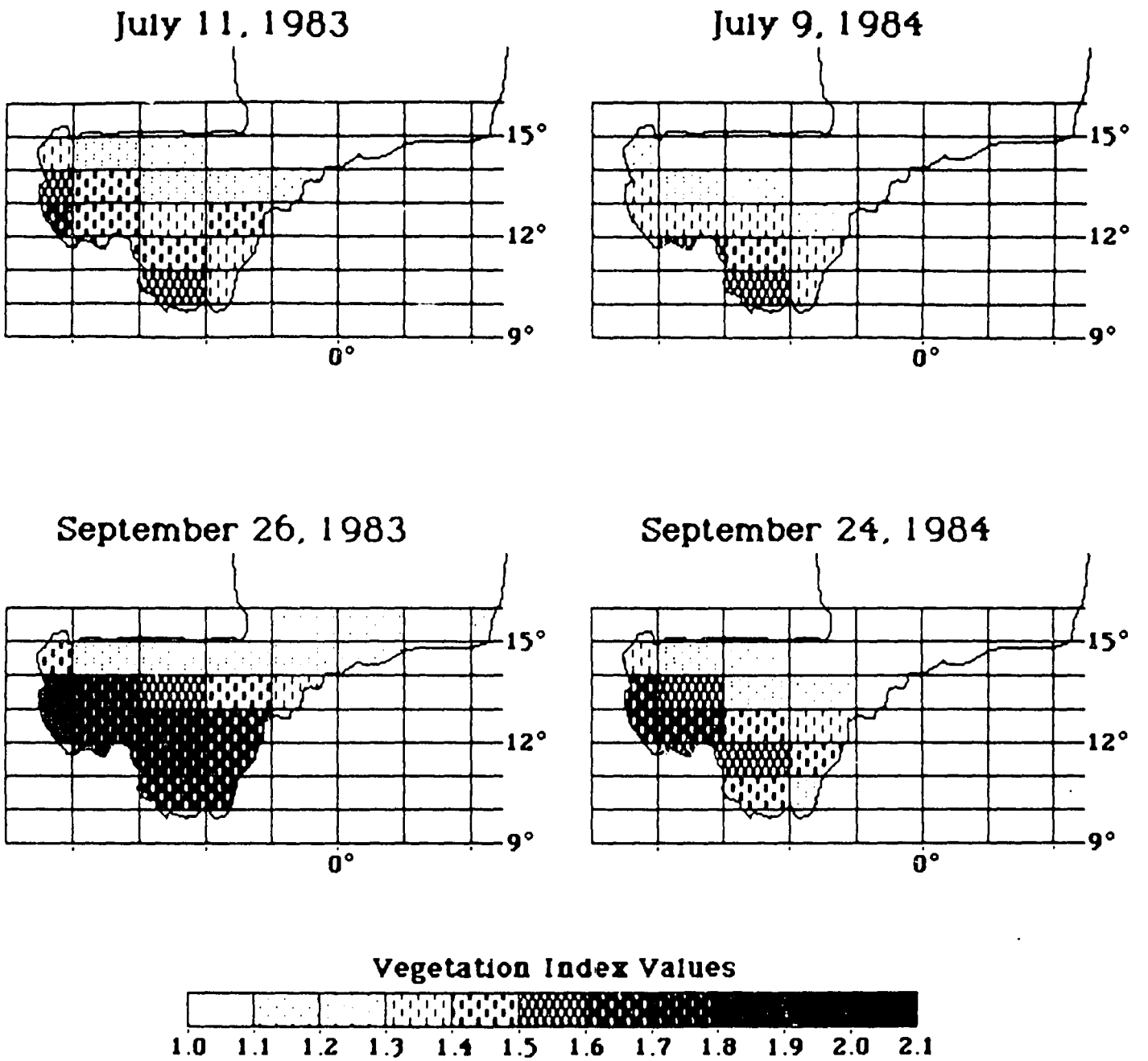
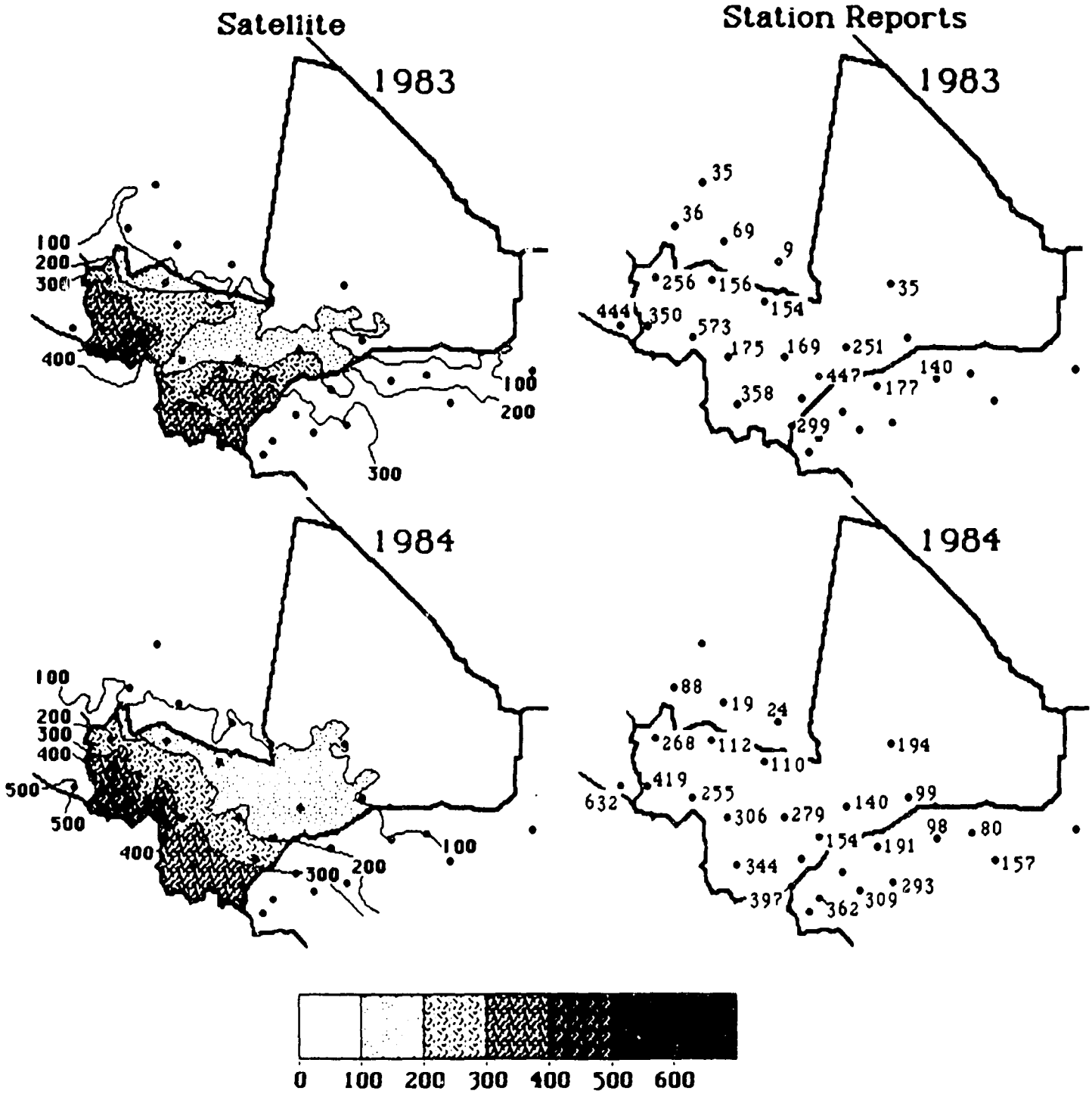


Figure 3

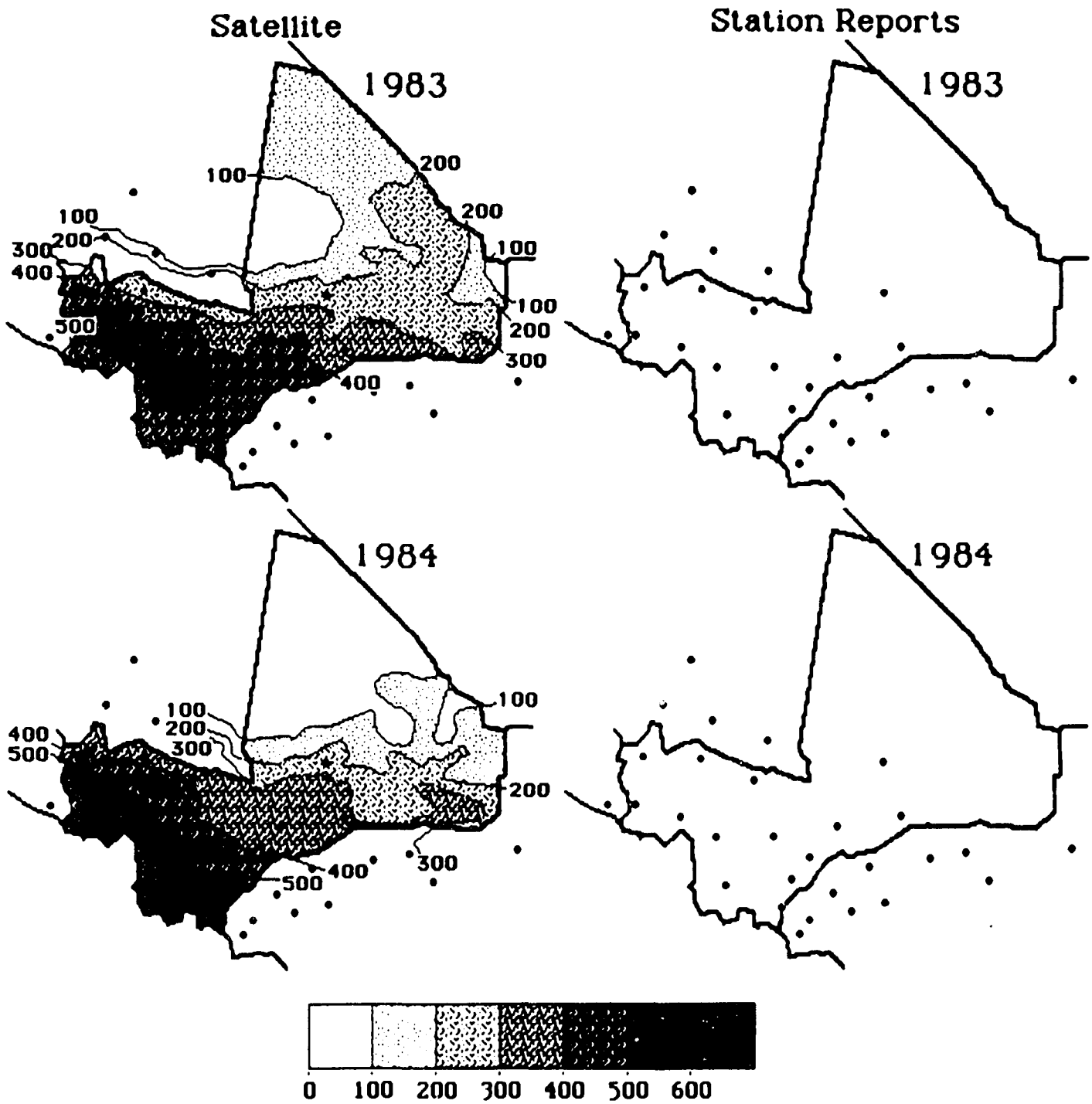
MALI: May - July Cumulative Rainfall Estimates Based on ACCS* Satellite Images and Station Reports



* ACCS is the Ambroziak Color Coordinate System which is designed to enhance visual perception of satellite images allowing this type of analysis to be easily done.

Figure 10

MALI: June - September Cumulative Rainfall Estimates Based on ACCS* Satellite Images



* ACCS is the Ambroziak Color Coordinate System which is designed to enhance visual perception of satellite images allowing this type of analysis to be easily done.

SUDAN

SPECIAL AGROCLIMATIC ASSESSMENT OF THE 1984 SEASON

Prepared by the Climate Impact Assessment Division, Assessment and Information Services Center of NOAA - November 28, 1984

RAINFALL REGIME

The rainfall amount tends to increase gradually from north to south, ranging from a few millimeters per year in the desert to about 1,600 mm in some of the tropical mountainous areas along the southern border (Figure 1). The southern limit of the desert approaches the 150 mm annual rainfall isoline, while the northern limit of rainfed farming coincides usually with the 350 mm isoline. Sudan has only one rainy season per year. At the 350 mm isoline areas, the rainy season normally begins in late June and lasts until early September. Towards the south, the rainy season begins earlier and lasts longer. The mean monthly rainfall for several selected stations shown on Figure 2 illustrates quite well the changes in both distribution and amount of rainfall from north to south.

AGRICULTURE

The most widespread food crop in the Sudan and the staple food for most of the population is sorghum, grown on over 3 million hectares. Locally it is called "durra". Unlike maize, sorghum gives a reasonable yield not only when the rainfall amount during the growing season is below the optimal, but also when the distribution of rainfall is very uneven. The second most important food crop in the Sudan is bulrush millet, grown on 1.25 million hectares. Locally it is called "dukhn". It is the most drought resistant cereal crop, but yields less than the others. Farmers in the south grow finger millet rather than bulrush millet. Relatively large areas are planted with groundnuts and sesame. Other food crops, in order of the size of the planted area, are wheat, pulses (dry beans, broad beans, peas), maize, cassava, etc. Most of the food crops in the Sudan are rainfed.

Sowing of most food crops in the central belt of the country begins normally during the second half of June, after the first rains of the season moisten the topsoil. The bulk of the sowing, however, is carried out in July. Harvesting begins in October and continues in November, even December.

ASSESSMENT OF THE 1984 SEASON

Note: Sudan is one of the few countries in the world for which current rainfall data are unavailable. Therefore, this assessment is based only on satellite data. Unfortunately, the latter is very limited. Due to introduction of new satellite technology, the 1984 season can be compared only with the one of 1983.

The cumulative rainfall estimates for two periods - through July and through September - are shown on Figure 3. In most areas of the country, especially in those with marginal rainfall, the 1984 rainfall for both periods is less than that in 1983. The biggest differences earlier in the season - through July - were the western areas of the central belt of the country (Darfur province, south of El Fasher), while later in the season - through September - the current year was drier in the central and eastern areas (east of En Nahud in Kordofan to the Ethiopian border).

A bette, comparison of the existing agroclimatic conditions in 1983 and 1984 can be made by using the extent of vegetation cover during these years, as shown on Figure 4. The indices were calculated for area rectangles of one degree latitude and two degrees longitude. At the end of the first decade of July, the 1984 vegetation cover was considerably less than that in 1983 in nearly all areas of the country except in the Southwest. Later in the season the vegetation cover in the southern areas improved and towards the end of September, the most pronounced differences were north of 11° latitude.

Figure 1.

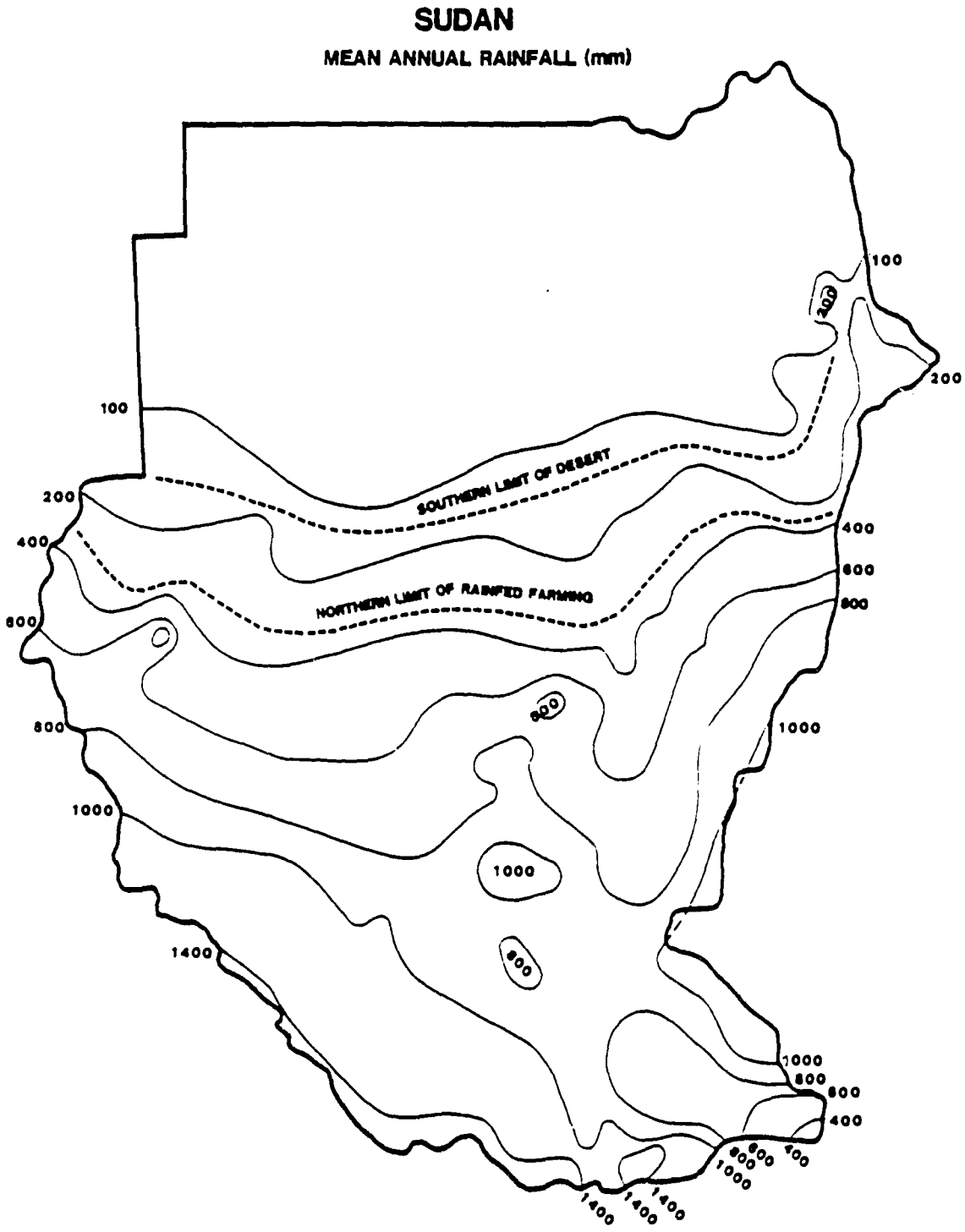

SUDAN
MEAN ANNUAL RAINFALL (mm)
SOUTHERN LIMIT OF DESERT
NORTHERN LIMIT OF RAINFED FARMING
100
200
400
600
800
1000
1400

Figure 2. Mean annual rainfall (on the map) and mean monthly rainfall (on the plots) for selected stations in the Sudan.

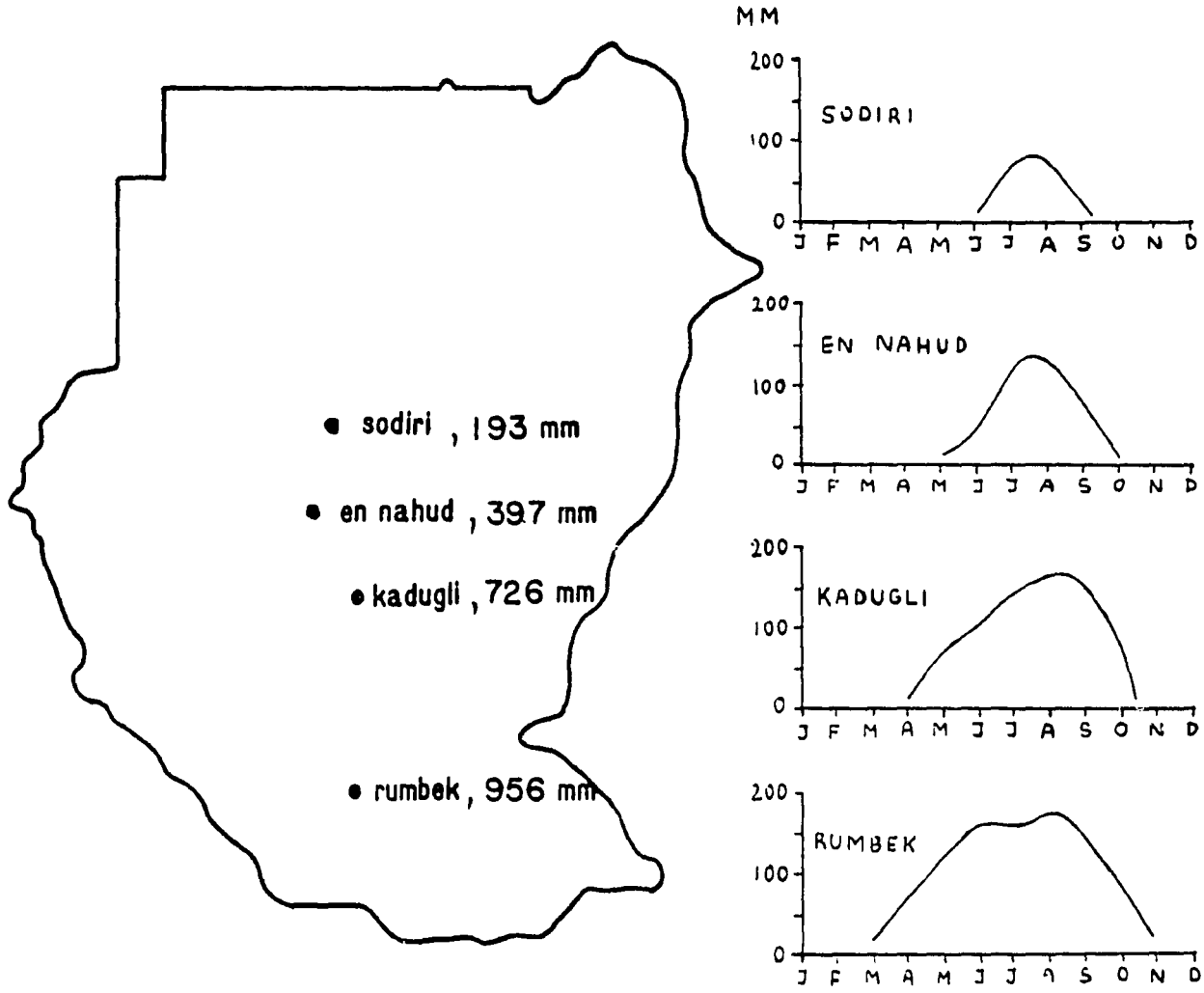
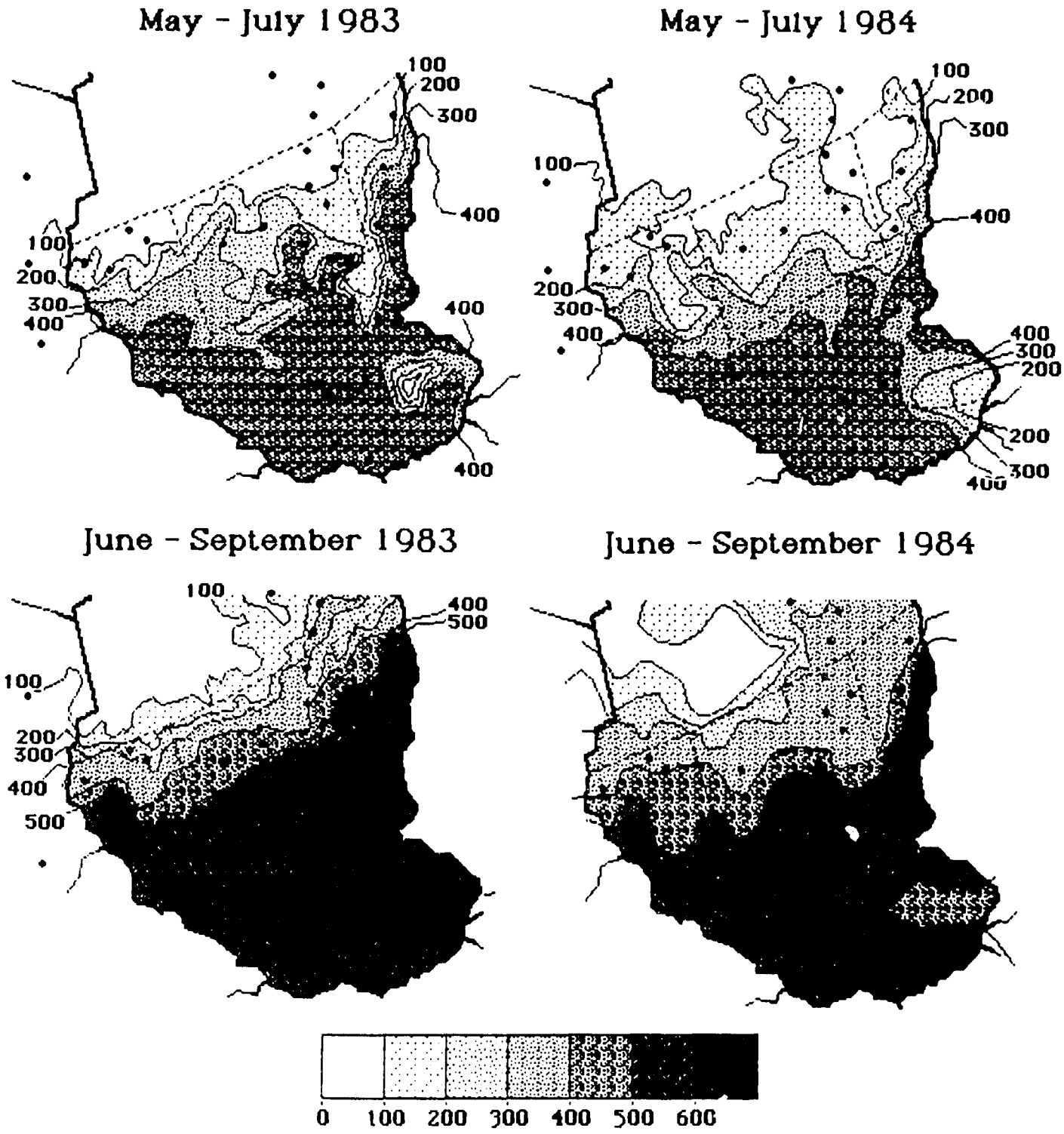


Figure 3

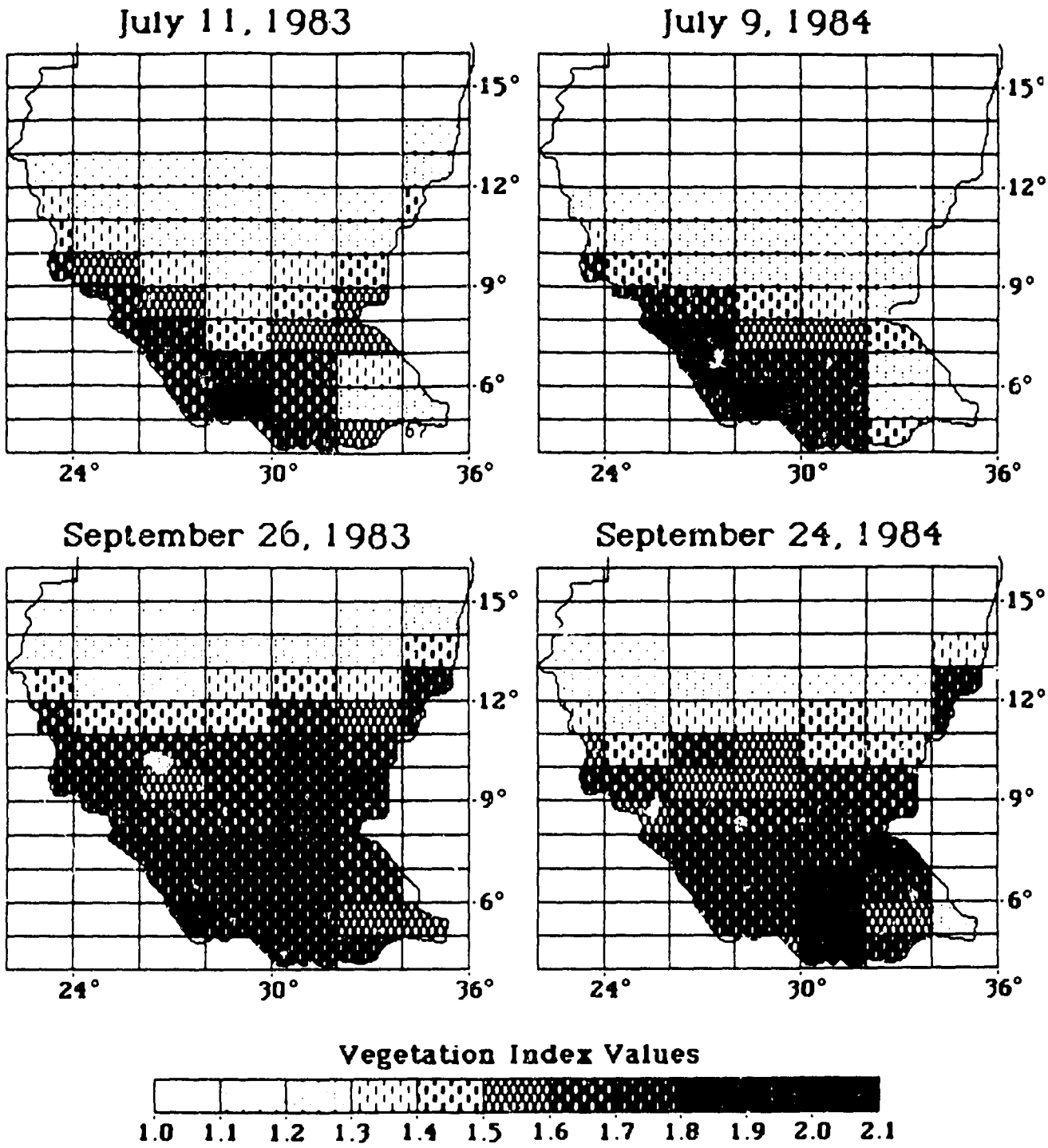
SUDAN: Cumulative Rainfall Estimates Based on ACCS* Satellite Images



* ACCS is the Ambroziak Color Coordinate System which is designed to enhance visual perception of satellite images allowing this type of analysis to be easily done.

Figure 4

SUDAN: Vegetation Indes from NOAA AVHRR Satellite Data



SPECIAL ASSESSMENT CABLES FOR AFRICA

94

UPPER VOLTA SEPTEMBER 10, 1984

AGENCY: NESDIS/ASSESSMENT AND INFORMATION SERVICES CENTER/CLIMATIC ASSESSMENT BRANCH

CLASSIFICATION: UNCLASSIFIED

ACCOUNTING CLASSIFICATION: EE4200/8N3D0406

DRAFTER: DLECOMTE, CAB - 634-1822

APPROVED: MREID, CAB - 634-1822

INFO: PKRUMPE, AID/OFDA

TO: AFRICA WEATHER/CROP COLLECTIVE

TAGS: TPHY

SUBJ: SPECIAL AGROCLIMATIC ASSESSMENT FOR SOUTHWEST BURKINA FASO FOR THE PERIOD MAY-AUGUST 1984

REF: OUAGADOUGOU 05214

1. OVERVIEW

WELL BELOW NORMAL YIELDS AND SERIOUS FOOD SHORTAGES ARE EXPECTED THIS YEAR IN SOUTHWEST BURKINA. ONCE AGAIN THE REGION WAS AFFECTED BY DROUGHT, COMPARABLE OR EVEN WORSE THAN THE DROUGHT IN 1983. AGROCLIMATIC CROP CONDITION INDICES AT THE END OF AUGUST ARE AT THE 8-13 PERCENTILE RANK (ON THE SCALE FROM 0 TO 100).

2. INTRODUCTION

THE SOUTHWEST REGION OF BURKINA FASO IS THE GRANARY OF THE COUNTRY. MAIZE IS THE PRINCIPAL FOOD CROP, FOLLOWED BY SORGHUM AND MILLET. THIS IS THE WETTEST PART OF THE COUNTRY. THE RAINY SEASON NORMALLY BEGINS IN MAY AND LASTS UNTIL EARLY OCTOBER. THIS SPECIAL ASSESSMENT IS BASED MAINLY ON DATA FROM 3 METEOROLOGICAL STATIONS IN SOUTHWEST BURKINA: BOROMO, BOBO DIOULASSO AND GAOUA. A STATION IN SOUTHERN MALI, SIKASSO, IS USED AS A REFERENCE. IT IS LOCATED CLOSE TO THE BURKINA BORDER AND IS REPRESENTATIVE OF AN AREA COVERING THE EXTREME SOUTHWEST CORNER OF BURKINA.

3. AGROCLIMATIC CONDITIONS

THE 1984 RAINY SEASON BEGAN ON TIME AND WITH ABUNDANT RAINFALL (TABLE 1). MAY RAINFALL IN BOROMO AND BOBO DIOULASSO WAS ABOUT 170 MM; IN GAOUA IT REACHED 245 MM. THESE ABOVE NORMAL AMOUNTS (160-210 PERCENT) WERE SUFFICIENT NOT ONLY FOR LAND PREPARATION, BUT ALSO FOR SOWING AND EMERGENCE OF THE CROPS.

JUNE RAINFALL OF ABOUT 100 MM IN BOROMO, BOBO DIOULASSO AND SIKASSO WAS BELOW NORMAL, BUT SATISFACTORY DUE TO LIMITED CROP WATER REQUIREMENTS. IN GAOUA, HOWEVER, 65 MM OF RAINFALL (ONLY 48 PERCENT OF NORMAL) WAS WELL BELOW THE OPTIMAL CROP WATER REQUIREMENTS.

THE MOST UNFAVORABLE AGROMETEOROLOGICAL CONDITIONS THIS SEASON OCCURRED IN JULY, ESPECIALLY IN BOROMO AND BOBO DIOULASSO, WHERE MONTHLY RAINFALL WAS BELOW 100 MM. AGROCLIMATIC CROP CONDITION INDICES FOR THESE TWO STATIONS AT THE END OF JULY WERE AT THE 5TH PERCENTILE RANK, INDICATING UNUSUALLY DRY CONDITIONS AND A DROUGHT THAT HAS A PROBABILITY OF OCCURRENCE ONLY ONCE IN 20 YEARS. THE INDICES IN GAOUA AND SIKASSO (13TH AND 11TH PERCENTILE RANK RESPECTIVELY) WERE ONLY SLIGHTLY HIGHER.

AUGUST IS THE MONTH WHEN CROPS HAVE THEIR HIGHEST WATER DEMAND. GAOUA CONTINUED TO BE THE DRIEST AREA IN SOUTHWEST BURKINA, WITH RAINFALL WELL BELOW THE OPTIMAL CROP WATER REQUIREMENTS. AT THE OTHER THREE STATIONS AUGUST RAINFALL WAS MORE FAVORABLE (74-99 PERCENT OF NORMAL), BUT UNUSUALLY HIGH AIR TEMPERATURES (2-4°C ABOVE THE NORMALS) NOT ONLY INCREASED SHARPLY THE WATER DEMAND, BUT MOST PROBABLY HAD ALSO A DIRECT ADVERSE EFFECT ON THOSE CROPS THAT WERE AT FLOWERING STAGE.

CUMULATIVE RAINFALL FOR JUNE, JULY AND AUGUST RANGED BETWEEN 370 MM IN GAOUA AND 440 MM AT THE OTHER TWO BURKINA STATIONS, OR ABOUT 70 PERCENT OF NORMAL. AT BOBO DIOULASSO THIS YEAR'S RAINFALL WAS THE SAME AS IN 1983, WHICH MARKED ONE OF THE WORST DROUGHTS IN SOUTHWEST BURKINA. AT GAOUA AND BOROMO, CUMULATIVE RAINFALL IN 1984 WAS ABOUT 25-40 MM LOWER THAN IN 1983.

TABLE 1. MONTHLY RAINFALL (MM), PERCENT OF NORMAL RAINFALL (%) AND THE PERCENTILE RANK OF THE AGROCLIMATIC INDICES (RANK) IN SOUTHWEST BURKINA IN 1984.

	MAY		JUNE			JULY			AUGUST		
STATION	MM	%	MM	%	RANK	MM	%	RANK	MM	%	RANK
BOROMO	174	195	101	90	36	84	43	5	252	99	13
BOBO DIOULASSO	173	159	111	87	30	98	44	5	235	74	8
GAOUA	245	211	65	48	8	154	84	13	155	72	13
SIKASSO	122	115	104	69	9	171	67	11	243	76	6

4. PLEASE CAPTION ALL RESPONSES FOR MALCOLM REID, NOAA/ASSESSMENT AND INFORMATION SERVICES CENTER (AISC), E/AI42.

(ORIGIN: AISC/NESDIS/NOAA/RCARTER)

KENYA OCTOBER 9, 1984

AGENCY: NESDIS/ASSESSMENT AND INFORMATION SERVICES CENTER/CLIMATIC ASSESSMENT BRANCH

CLASSIFICATION: UNCLASSIFIED

ACCOUNTING CLASSIFICATION: EE4200/8N3D0406

DRAFTER: DLECOMTE, CAB - 634-1822

APPROVED: MREID, CAB - 634-1822

INFO: PKRUMPE, AID/OFDA

TO: AMEMBASSY NAIROBI

FROM: NOAA/NESDIS/AISC

REF: NAIROBI 30124

SUBJ: WEATHER FORECAST FOR KENYA

1. DUE TO SEVERE DROUGHT DURING THE FIRST HALF OF 1984, KENYA'S SHORT RAINS ARE ESPECIALLY IMPORTANT THIS YEAR. The short rainy SEASON GENERALLY RUNS FROM OCTOBER TO DECEMBER, WITH PEAK RAINFALL IN NOVEMBER. RAINFALL AMOUNTS, HOWEVER, ARE EXTREMELY VARIABLE. OCTOBER-DECEMBER CUMULATIVE RAINFALL IN KENYA'S CENTRAL AGROCLIMATIC REGION VARIED FROM 58 MM TO 315 MM DURING THE 1951-1979 PERIOD.

2. NOAA/AISC DOES NOT MAKE LONG-TERM WEATHER FORECASTS. HOWEVER, WE HAVE EXAMINED THE HISTORICAL RAINFALL DATA TO SEE IF A CORRELATION EXISTS BETWEEN THE LONG AND THE SHORT RAINY SEASON. IT IS PARTICULARLY REVELANT TO SEE IF DROUGHT THE FIRST HALF OF THE YEAR TENDS TO BE FOLLOWED BY BELOW-NORMAL RAINFALL LATER IN THE YEAR. WE FOUND THAT THERE IS NO CORRELATION BETWEEN THE TWO RAINY SEASONS. DROUGHT EARLY IN THE YEAR DOES NOT INCREASE THE CHANCES FOR DROUGHT LATE IN THE YEAR. IN FACT, NO USEFUL CORRELATION BETWEEN THE TWO SEASONS IS DISCERNIBLE IN THE DATA.

3. WE CONCLUDE THAT THE EXISTENCE OF THE EARLIER DROUGHT IS NOT SUFFICIENT REASON TO FORECAST A DEFICIENT SHORT RAINY SEASON THIS YEAR. RAINFALL SO FAR IN OCTOBER HAS BEEN NEAR OR ABOVE NORMAL OVER MUCH OF THE COUNTRY, CREATING FAVORABLE CONDITIONS FOR THE EARLY GROWTH OF SHORT RAINS CROPS. AN INFLUX OF LOW AND MID-LEVEL MOISTURE FROM THE INDIAN OCEAN HAS HELPED CREATE FAVORABLE CONDITIONS FOR SHOWER DEVELOPMENT THIS MONTH. IN ADDITION, THE INTERTROPICAL CONVERGENCE ZONE IS LOCATED NEAR KENYA. UNFORTUNATELY, HISTORICAL DATA ALSO SHOW THAT ABUNDANT RAINS IN OCTOBER DO NOT IMPLY SIMILAR RAINS IN NOVEMBER.

(ORIGIN: NOAA/AISC/CIAD/CAB/RCARTER)

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CHAD OCTOBER 25, 1984

AGENCY: NESDIS/ASSESSMENT AND INFORMATION SERVICES CENTER/CLIMATIC ASSESSMENT BRANCH

CLASSIFICATION: UNCLASSIFIED

ACCOUNTING CLASSIFICATION: EE4200/8N3D0406

DRAFTER: DLECOMTE, CAB - 634-1822

APPROVED: MREID, CAB - 634-1822

INFO: PKRUMPE, AID/OFDA

TO: AFRICA WEATHER/CROP COLLECTIVE

FM: NOAA/NESDIS/AISC

TAGS: TPHY

REF: NDJAMENA 5237

SUBJ: SPECIAL AGROCLIMATIC ASSESSMENT FOR CHAD

1. METHOD OF ASSESSMENT. THE AGROCLIMATIC ASSESSMENTS NOAA PREPARES FOR THE SAHEL COUNTRIES USE TWO BASIC SOURCES OF RAINFALL DATA: OBSERVED RAINFALL AND RAINFALL ESTIMATES FROM SATELLITE IMAGES. UNFORTUNATELY, OBSERVED RAINALL DATA FOR CHAD WERE UNAVAILABLE DURING THIS SEASON AND THE ASSESSMENTS WERE BASED ONLY ON SATELLITE-ESTIMATED RAINFALL. SUCH ASSESSMENTS HAVE TWO MAIN DRAWBACKS: THEY ARE NOT AS ACCURATE AS THOSE BASED ON OBSERVED DATA AND, SECONDLY, THEY ARE MADE FOR AN ENTIRE REGION; THE CONDITIONS EXISTING IN DIFFERENT AREAS OF A GIVEN REGION ARE NOT ASSESSED SEPARATELY. CHAD WAS DIVIDED INTO THREE AGROCLIMATIC REGIONS: NORTH (NORTH OF ABOUT 15° LATITUDE), CENTRAL (BETWEEN 15° AND 11° 30') AND SOUTH (SOUTH OF 11° 30').

2. NORTH REGION. NO RAIN-FED CROPS ARE GROWN IN THIS REGION.

3. CENTRAL REGION. SATELLITE DATA SUGGESTED THIS YEAR'S RAINY SEASON BEGAN LATER THAN USUAL AND WITH BELOW NORMAL RAINFALL FOR EACH INDIVIDUAL MONTH. AGROCLIMATIC CROP CONDITION INDICES DROPPED FROM THE 30TH PERCENTILE RANK AT THE END OF JUNE, TO THE 12TH PERCENTILE RANK AT THE END OF JULY, AND TO THE 5-6 PERCENTILE RANK AT THE END OF AUGUST AND SEPTEMBER, INDICATING SEVERE DROUGHT - ONE THAT OCCURS ONLY ONCE IN ABOUT 20 YEARS. SUCH DROUGHTS ARE USUALLY ASSOCIATED WITH WELL BELOW NORMAL YIELDS, EVEN COMPLETE CROP FAILURES IN SOME AREAS.

4. SOUTH REGION. SATELLITE DATA INDICATE THE RAINY SEASON BEGAN ON TIME IN MAY, WITH ABOUT 100 MM OF RAINFALL (130 PERCENT OF NORMAL), FAVORING FIELD WORK AND CROP SOWING. THE FOLLOWING MONTH (JUNE) WAS DRY WITH ONLY 80 MM OF RAINFALL, 56 PERCENT OF NORMAL. APPARENTLY THIS HAD AN ADVERSE EFFECT ON THE NEWLY PLANTED CROPS. THEIR STATE COULD HAVE BEEN IMPROVED ONLY BY ABOVE NORMAL RAINFALL IN JULY AND AUGUST. UNFORTUNATELY, BOTH MONTHS WERE ALSO DRIER THAN NORMAL,

WITH INDICES AROUND THE 5-6 PERCENTILE RANK, SUGGESTING WELL BELOW NORMAL YIELDS AND THE POTENTIAL FOR SERIOUS FOOD SHORTAGES. PLENTIFUL RAINFALL IN SEPTEMBER CAME TOO LATE TO IMPROVE YIELD PROSPECTS, THOUGH GRAZING CONDITIONS IMPROVED.

5. OBSERVED RAINFALL. RAINFALL DATA FOR INDIVIDUAL STATIONS WERE OBTAINED BY DR. STEYAERT AFTER HIS RECENT VISIT TO CHAD. THEY INDICATE THAT SOME AREAS IN THE CENTRAL REGION (CHARI BAGUIRMI AND GUERA PREFECTURES), AS WELL AS MOST OF THE WESTERN HALF OF THE SOUTH REGION, RECEIVED RAINFALL AROUND OR ABOVE NORMAL THIS SEASON. ALL THESE AREAS WERE MUCH DRIER LAST YEAR, AND THEREFORE, CROP YIELDS THIS YEAR ARE EXPECTED TO BE MUCH HIGHER THAN IN 1983. THE OBSERVED RAINFALL DATA FURTHER INDICATE THAT THIS YEAR'S DROUGHT IS AFFECTING ONLY THE EASTERN HALF OF THE SOUTH REGION AND KANEM, LAKE CHAD, BATHA, AND OUADDAI PREFECTURES IN THE CENTRAL REGION.

6. VEGETATION INDICES. SATELLITE VEGETATION INDICES AVAILABLE THE LAST TWO YEARS POINT TO THE LIKELIHOOD OF LOWER YIELDS IN 1984 IN SOUTHEASTERN BATHA AND WESTERN OUADDAI. ANOTHER AREA WITH LOWER VEGETATION INDEX VALUES THIS YEAR INCLUDES EXTREME NORTHERN CHARI-BAGUIRMI, THE LAKE CHAD REGION, AND SOUTHERN KANEM. BEST CROP POTENTIAL IS INDICATED FOR MOYEN CHARI AND SOUTHERN GUERA, WITH MOYEN CHARI IMPROVED OVER LAST YEAR.

7. SUMMARY. HOT, DRY WEATHER SHARPLY REDUCED YIELDS IN CHAD'S CENTRAL (SAHEL) REGION, PARTICULARLY IN EXTREME NORTHERN CHARI-BAGUIRMI, THE LAKE REGION, KANEM, BATHA, BILTINE, AND OUADDAI. CROP LOSSES ARE ALSO POSSIBLE IN SALAMAT PREFECTURE. THE POTENTIAL FOR SEVERE FOOD SHORTAGES AND LIVESTOCK DEATHS EXISTS IN THESE AREAS UNTIL THE 1985 HARVESTS. HIGHER RAINFALL TO THE SOUTH, ESPECIALLY IN WESTERN AREAS, PROVIDED THE POTENTIAL FOR NORMAL TO ABOVE-NORMAL YIELDS OF CEREAL CROPS FOR THE CURRENT HARVEST. THESE AREAS ACCOUNT FOR NEARLY 80 PERCENT OF CHAD'S CEREAL PRODUCTION. AS ESTIMATED GRAIN PRODUCTION WAS GREATLY REDUCED IN OUADDAI-BILTINE DURING 1983 AND THIS REGION WAS ALSO AFFECTED BY DRYNESS DURING 1984, THE GREATEST THREAT OF FAMINE APPEARS TO BE LOCATED IN THIS EASTERN PORTION OF THE CENTRAL REGION.

(ORIGIN: NOAA/AISC/CIAD/CAR/RCARTER)

SPECIAL ASSESSMENT CABLES

SRI LANKA MARCH 23, 1982

01 03 UNCLASSIFIED N/A NOA/3/23/82

{202} 634-1822

CAB MREID CAB RAMBROZIAK

MR. R.A

AMEMBASSY COLUMBO

SUBJ: NOAA/CEAS RESPONSE TO COLUMBO

CAP: PASS TO PAUL KRUMPE, AID OFDA

REF: COLUMBO 3797

SRI LANKA APPEARS TO BE UNDERGOING THE WORST DROUGHT ON RECORD IN THE DRY {NORTH AND EAST COASTAL} AND HILL {CENTRAL} REGIONS OF THE COUNTRY. THEIR IRRIGATION PRACTICES MAKE THE LENGTH OF DROUGHT AS IMPORTANT AS THE SEVERITY. THE MAHA CROP IS GROWN DURING THE WETTER NORTHEAST MONSOON FROM SEPTEMBER TO APRIL, WHEN EXCESS WATER IS STORED FOR LATER USE. THE PAST TWO MAHA SEASONS AND THE INTERVENING YALA SEASON OR SOUTHWEST MONSOON FROM MAY TO AUGUST HAVE BEEN EXCEPTIONALLY DRY. THE 18-MONTH PERIOD ENDING IN FEBRUARY 1982 IS THE DRIEST IN THE MORE THAN 100 YEARS THAT

UNCLASSIFIED

RECORDS HAVE BEEN KEPT. BASED ON AVAILABLE DATA A WORSE PERIOD FOR THE DRY AND HILL REGIONS OF SRI LANKA COULD NOT BE FOUND. RAINFALL IN THE {SOUTHWEST COASTAL} WET REGION WAS NOT AT RECORD LOW LEVELS, BUT IT WAS BELOW AVERAGE, INCREASING THE SERIOUSNESS OF THE SITUATION.

PERIODS OF HEAVY RAIN HAVE OCCURRED IN SOME REGIONS, BUT LONG-TERM ACCUMULATED RAINFALL HAS NOT BEEN OUT OF THE DROUGHT CATEGORY IN MOST AREAS DURING ANY OF THE PAST THREE MONSOONS. THE SOUTHWEST MONSOON {YALA SEASON} IN THE DRY REGION WAS AN EXCEPTION, BUT THIS REGION NORMALLY RECEIVES SO LITTLE RAIN DURING THE SOUTHWEST MONSOON THAT THE SMALL ADDITIONAL RAINFALL THERE DID NOT HELP.

STRONGLY SUGGEST CONTACTING SRI LANKA AND INDIA METEOROLOGICAL SERVICES FOR MONSOON FORECAST INFORMATION. IN FUTURE ASSESSMENTS, NOAA WILL PROVIDE INFORMATION ON THE PROGRESS OF MONSOON, AS DERIVED FROM SATELLITE IMAGERY AND UPPER AIR DATA.

PLEASE CAPTION ALL RESPONSES FOR MALCOLM REID, NOAA/CENTER FOR ENVIRONMENTAL ASSESSMENT SERVICES {CEAS}, D242 ROOM 135, PAGE 2, WASHINGTON, DC 20235.

CEAS/EDIS/NOAA/RCARTER

NEPAL SEPTEMBER 10, 1982

AGENCY:NESDIS/ASSESSMENT AND INFORMATION SERVICES CENTER/CLIMATIC ASSESSMENT BRANCH

CLASSIFICATION: IMMEDIATE PRECEDENCE LIMITED OFFICIAL USE

ACCOUNTING CLASSIFICATION: EE4200/8N3D0406

DRAFTER: MCHUSMIR, CAB - 634-1822

APPROVED: MREID, CAB - 634-1822

INFO: PKRUMPE, AID/OFDA

TO: AMEMBASSY KATHMANDU

FROM: USDOC WASHINGTON, DC

SUBJ: SPECIAL NOAA/CEAS CLIMATIC IMPACT ASSESSMENT - NEPAL

REF: KATHMANDU 4898

1. THIS SPECIAL ASSESSMENT ON FORECASTED PADDY RICE AND WHEAT PRODUCTION IS PROVIDED IN RESPONSE TO KATHMANDU 4898 (09 SEP 82). PLEASE PASS TO US/AID MISSION.

2. NATIONAL PADDY RICE. THE PRELIMINARY 1982 FORECASTED PADDY RICE YIELD IS 1.70 METRIC TONS PER HECTAGE BASED ON CEAS ESTIMATED MAY THRU AUGUST RAINFALL. THIS COMPARES TO GON REPORTED RECENT 1979 LOW YIELD (1.64 MT/HA) AND 1975 HIGH YIELD (2.07 MT/HA). IF SEPT 82 IS DRY, FORECAST COULD BE FURTHER REDUCED. FOR EXAMPLE, SEP 82 RAINS OF 65 PERCENT NORMAL WOULD RESULT IN PADDY FORECASTED YIELD AT 1.60 MT/HA. PADDY SOURCES (1964-1980) ARE "AGSTIX OF NEPAL (1977, TABLES 6 AND 7)" PLUS IN-COUNTRY CORRESPONDENCE. BELIEVE DATA ARE FOR EARLY PLUS MAIN PADDY RICE. PRODUCTION ESTIMATE FOR 1982 RANGES FROM 2.142 MILLION METRIC TONS (1.70 MT/HA YIELD) TO 2.016 MMT (1.60 MT/HA) WITH ASSUMED 1.260 MILLION HECTARES PADDY AREA. THESE PRODUCTION FORECASTS (2.142 TO 2.016 MMT) COMPARE TO 1978-1980 AVERAGE PRODUCTION (2.288 MMT) AND 1974-1976 AVERAGE PRODUCTION (2.481 MMT).

3. NATIONAL WINTER WHEAT. PRELIMINARY ANALYSIS ON 1982/83 WINTER WHEAT PROSPECTS STRONGLY SUGGESTS POTENTIAL SEVERE DROUGHT IMPACT EVEN THOUGH THE CROP IS NOT NORMALLY PLANTED UNTIL NOVEMBER AND DECEMBER. THERE IS A SIGNIFICANT STATISTICAL ASSOCIATION BETWEEN WINTER WHEAT PRODUCTION AND THE PRECEDING SOUTHWEST MONSOON RAINFALL. THE NEPAL CLIMATE/WHEAT YIELD MODEL FORECASTS 1982/83 WINTER WHEAT PRODUCTION AT 294,000 MT, REPRESENTING 66 PERCENT 1978-1980 BASE PERIOD PRODUCTION OF 444,000 MT. THIS ASSUMES SEP 82 RAINFALL OF 65 PERCENT NORMAL AND SUGGESTS A 154,000 MT DEFICIT RELATIVE TO BASE PERIOD PRODUCTION. MODEL FORECASTED YIELD IS 0.79 MT/HA (66 PERCENT OF BASE PERIOD YIELD). PRODUCTION ESTIMATES ASSUME MEAN WHEAT AREA OF 372,000 HA FOR SAME BASE PERIOD. THIS FORECAST IS COMPARABLE

93'

TO 1981/82 MODEL FORECASTED WHEAT PRODUCTION OF 300,000 MT, 68 PERCENT OF BASE PERIOD PRODUCTION.

4. THIS ASSESSMENT IS BASED ON RECENTLY DEVELOPED STATISTICAL CLIMATE/CROP YIELD FORECAST MODELS FOR MAIN RICE AND WINTER WHEAT DETERMINED FROM A 1964-1975 NATIONAL YIELD AND METEOROLOGICAL DATA. MAIN RICE MODELS GENERALLY USE MAY THROUGH AUGUST (OR SEPTEMBER) RAINFALL AS PREDICTOR INPUT. WHEAT MODELS ARE BASED ON AUGUST - SEPTEMBER RAINFALL THAT PRECEDES NOV/DEC PLANTING. MODELS PROVIDE ABSOLUTE YIELD FORECASTS WHICH ONLY INDICATE A MEASURE OF DROUGHT IMPACT. IMPACT OF OTHER FACTORS (PESTS, FLOODING, ETC) MUST BE SEPARATELY ASSESSED. THESE MODEL FORECASTS ARE CONSISTENT WITH PREVIOUS CEAS CLIMATIC IMPACT ASSESSMENTS BASED ON AGROCLIMATIC/CROP CONDITION INDICES FOR MAIZE AND MAIN RICE.

5. FOLLOW-UP SPECIAL ASSESSMENT WILL BE PROVIDED. ANALYSIS AFTER SEPTEMBER 30 WILL MORE CONFIDENTIALLY IDENTIFY DROUGHT IMPACT ON 1982/83 PADDY AND WHEAT CROPS.

6. PLEASE CAPTION ALL RESPONSES FOR MALCOLM REID, NOAA/CENTER FOR ENVIRONMENTAL ASSESSMENT SERVICES (CEAS), D242.

(ORIGIN: NOAA/CEAS/RCARTER)

INDIA FEBRUARY 15, 1983

AGENCY: NESDIS/ASSESSMENT AND INFORMATION SERVICES CENTER/CLIMATIC ASSESSMENT BRANCH

CLASSIFICATION: UNCLASSIFIED

ACCOUNTING CLASSIFICATION: EE4200/8N3D0406

DRAFTER: MCHUSMIR, CAB - 634-1822

APPROVED: MREID, CAB - 634-1822

INFO: PKRUMPE, AID/OFDA

TO: ASIA WEATHER/CROP COLLECTIVE

TAGS: TPHY

SUBJ: UPDATE ASSESSMENT FOR SOUTH ASIA

1. SOUTH INDIA - THE SUMMER RICE CROP (MARCH HARVEST) IN KERALA IS BEING ADVERSELY IMPACTED BY DROUGHT. THE RICE CROP CONDITION INDEX (EXPRESSED IN PERCENTILES ON A SCALE FROM 0 TO 100), IS AT THE 10TH PERCENTILE RANGE SUGGESTING POOR CONDITIONS. PROSPECTS FOR THE MARCH TRANSPLANTING OF THE SUMMER RICE CROP IN TAMIL NADU REMAIN BLEAK DUE TO LACK OF ADEQUATE IRRIGATION SUPPLIES IN TANKS AND RESERVOIRS.

2. RAINFALL DURING THE 1982/83 NORTHEAST MONSOON SEASON WAS WELL BELOW NORMAL IN TAMIL NADU AND KERALA. THE MONSOON INDEX VALUES ARE IN THE LOWER 10TH PERCENTILE RANGE INDICATING SEVERE DROUGHT CONDITIONS. IN PARTICULAR, THE SITUATION IN TAMIL NADU IS COMPOUNDED BY AN EARLIER FAILURE OF THE SECONDARY SOUTHWEST MONSOON RAINS. THE CURRENT DROUGHT IN TAMIL NADU IS COMPARABLE TO THAT OF 1968/69 WHEN BOTH THE MONSOONS FAILED.

3. PLEASE CAPTION ALL RESPONSES FOR MALCOLM REID, NOAA/ASSESSMENT AND INFORMATION SERVICES CENTER (AISC), E/AI42.

(ORIGIN: NOAA/CEAS/RCARTER)

95

PHILIPPINES SEPTEMBER 15, 1983

AGENCY: NESDIS/ASSESSMENT AND INFORMATION SERVICES CENTER/
CLIMATIC ASSESSMENT BRANCH

CLASSIFICATION: LIMITED OFFICIAL USE

ACCOUNTING CLASSIFICATION: EE4200/8N3D0406

DRAFTER: LSTEYAERT, MB - 8-276-5263

APPROVED: RAMBROZIAK, CIAD - 634-7288

INFO: PKRUMPE, AID/OFDA

TO: AMEMBASSY MANILA
SECSTATE WASHDC
AID/AC, FOR AID TDY WARNKEN, MDRO CARTER AND ADO R. EDWARDS
FOR AID/W PASS TO AID/OFDA

TAGS: TPHY

SUBJ: SPECIAL NOAA/AISC AGROCLIMATIC ASSESSMENT ON 1981/83 DROUGHT

1. As requested, this special agroclimatic assessment of 1981/83 drought impact in the Central and Southern Philippines is provided. This impact assessment was made in retrospect based on station rainfall data only for the Bicol, Visayas and Mindanao Regions and it supplements previous NOAA/AISC bi-weekly assessments which are based mostly on regional rainfall analysis.

2. Methodology. Monthly rainfall data provided by PAGASA through US/AID for stations in below table were used in analysis (REFTEL Manila 19970 and 20467). Period of record for available data is in general 1951 through June, 1983. Data were used in NOAA/AISC agroclimatic crop condition/food shortage assessment models as modified by PAGASA report, "Agroclimatic Assessment Models for Policy Decision Making, Economic Planning and Rural Development in the Philippines" (Aida Jose, 1982). This assessment only considers drought impact on crops, not crop losses due to other weather

factors such as excessive rainfall or typhoon/tropical storm damage or non-weather factors. Information on crop conditions and relative crop yields is provided, not estimates of production or harvested acreage. Crops assessed include upland paddy, lowland first paddy, lowland second paddy, dry maize and wet maize. To ensure clarity and avoid potential confusion, the planting months and harvest months used in AISC analysis are also indicated along with each crop season name used by GOP. Agroclimatic crop condition indices for each crop are expressed in percentiles, ranging on a scale from 0 to 100. As a general rule, index values ranging from 0 to 10 suggest severe drought impact/potential crop failure, 11 to 20 suggest drought impact/major yield reductions, 21 to 30 suggest well below normal crop yields due to drought impact, 31 to 40 suggest below normal yields due to moderate drought impact, 41 to 85 suggest near normal to good yields and index values greater than the 85 to 90th percentiles suggest the potential for flood damages. As a final note, limitations to be considered for interpretation of this assessment include some uncertainty in GOP crop season naming conventions and crop calendars uniquely determined by local microclimatic conditions. In addition, the distribution of available rainfall stations was not totally adequate for some major crop areas. Therefore, AISC analysis focused on rainfall stations as regional indicators.

3. Overview. Recent severe drought impacts reported during early 1983 in the Central and Southern Philippines are the result of long-term drought conditions that initially began during June 1981 and persisted to about June 1983. During these two years there were four major drought periods characterized as follows: 1) severe drought impact, Oct/82-Jun/83, affecting Bicol, Visayas and Mindanao Regions, 2) drought impact, Jun/82-Sep/82 primarily affecting Western and Central Visayas plus Northern

Mindanao, 3) moderate drought impact, Nov/81-Apr/82, affecting Central Visayas, Western Visayas and Mindanao, and 4) severe drought impacts, Apr/81-Oct/81, affecting all regions. In general, the most severely impacted regions have been the Central Visayas, Western Visayas and North/Northwest areas of Mindanao. The long-term cumulative effect of the drought tended to significantly increase the impacts experienced during early 1983. General comments on individual drought periods noted below are followed by more detailed comments on impacts to specific crops in each year.

A. Drought: Oct/82-Jun/83

Agroclimatic crop index models suggest drought impact ranging from significant yield reductions to crop failure in the lowland second paddy rice crop (generally transplanted Oct/Nov 82) throughout all regions. The dry maize crop (Nov/Dec 82 planting) in the Central and West Visayas Regions plus West Mindanao, the wet maize crop (Feb/Mar planting) in the Bicol and East Visayas Regions and the dry maize crop (April, 1983 planting) in the Bicol and East Visayas Regions. The losses in the lowland second paddy crop are very significant because the crop in these regions accounts for about 16 percent of national rice production (percentages based on 1975-1978 GOP production reports). Similarly, dry maize in Bicol, Visayas and Mindanao accounts for 19 percent of total dry and wet maize production.

B. Drought Impacts: Jun/82-Sep/82

The worst drought impact was probably in Northern Mindanao and portions of the West and Central Visayas. Drought reduced the yields of lowland first paddy rice (generally transplanted Jun/Jul 82), wet maize (generally May/Jun 82 planting) and upland rice (generally May/Jun 82 planting) in these regions. Also, dry maize crops (generally Apr 82 planting) in the

Bicol and East Visayas regions experienced moderate drought impact leading to below normal yields.

C. Drought Impacts: Nov/81-Apr/82

Although the lowland second paddy rice crop was near normal in all regions, the dry maize crop experienced moderate drought impact leading to slightly reduced yields in West and Central Visayas (Nov 81 planting) plus Northern Mindanao (May 81 planting).

D. Drought Impact: Apr/81-Oct/81

Below normal SW monsoon rainfall (Jun-Sep/81) caused sharply reduced yields on the upland paddy (May/Jun planting) and lowland first paddy crops (Jun/Jul transplanting) in portions of the East, Central and West Visayas plus Mindanao. Similarly, wet maize in the West and Central Visayas and Mindanao (May-Jun/81 planting), wet maize in the Bicol (Feb/Mar 81 planting) and dry maize in the Bicol (Apr planting) experienced yield losses due to drought.

4. Lowland - First Paddy (Normally Jun-Jul transplanting)

A. 1982 Crop Season

1) Bicol (about 9 percent of National Lowland First Paddy Production). No evidence of drought impact. Rainfall conditions appeared adequate in vicinity of Camarines Sur paddy area.

2) East Visayas (about 11 percent National Lowland First Paddy). No evidence of drought impact in Samar del Norte paddy area. Although drought impact was severe at Borongan (crop index at 3rd percentile), it is believed that little to no rice is produced on the east coast. By inference from very poor conditions at Cebu (crop index at 15th percentile), there is the possibility of some drought impact in paddy areas on west coast of Leyte.

3) Central Visayas. Although only about 2 percent of National Lowland Paddy is produced, there is strong evidence for drought impact. Agroclimatic crop/condition indices for the first crop paddy are at the 15th percentile at Cebu, 24th percentile at Dumaguete and 33rd percentile at Tagbilaran. Paddy in these regions requires irrigation.

4) Western Visayas (about 13 percent of National Lowland First Paddy). Lack of adequate station coverage and mixed results for crop indices creates uncertainty in overall paddy assessment for Panay. There is evidence of drought impact in the vicinity of Roxas City (crop index, 15th percentile) in the north, but significant rainfall was received in the south (Iloilo, crop index 88th percentile). Assessment on west coast of Panay not feasible with available station data.

5) Mindanao (about 22 percent of National Lowland First Paddy). Very little data existed to assess major paddy areas in Mindanao and Agusan river valleys. However, there is strong evidence for monsoon failure at Malaybalay (crop/monsoon index at 3rd percentile) which is in the catchment area for the Mindanao River. Crop index values for other locations provided in table below.

B. 1981 Crop Season.

1) Bicol. Agroclimatic crop conditions favorable in Camarines Sur.

2) East Visayas. Evidence for moderate drought impact in Samar del Norte; crop index values at 18th percentile at Catbalogan and 39th percentile at Catarman. Conditions normal at Tacloban. Conditions on west coast of Leyte probably normal.

3) Central Visayas. Conditions effectively normal.

4) West Visayas. Evidence for drought impact in Panay. Crop indices are at the 12th percentile at Roxas and 26th percentile at Iloilo.

5) Mindanao. Evidence for severe drought impact throughout Mindanao probably affecting major paddy producing areas. Crop indices ranged from 10-15th percentile at most locations.

5. Lowland-Second Paddy (Normally November-December transplanting)

A. 1982/83 Crop Season.

There is very strong evidence that the 1982/83 lowland second paddy crop was close to a complete failure throughout the Bicol (about 10 percent national second paddy), East Visayas (similarly, 5 percent national), Central Visayas (2 percent national), West Visayas (11 percent national) and Mindanao (15 percent national). This suggests almost a 43 percent loss in national second paddy production which normally accounts for about 33 percent of all paddy production. Agroclimatic crop condition indices (see table below) generally range from the 3rd to 10th percentile at most stations. This indicates large-scale, severe drought impact. Rainfall during the growing season was only about 50 percent of normal.

B. 1981/82 Crop Season.

Agroclimatic crop conditions for lowland second paddy were essentially normal throughout the Bicol, Visayas and Mindanao Regions. The crop should have been very successful.

6. Upland Paddy (Generally planted May-Jun)

A. 1982 Crop Season.

Agroclimatic crop condition indices suggest normal to above normal upland paddy conditions in the Bicol and East Visayas regions, moderate drought impact in West Central Visayas (crop index about 35th percentile at all locations except Iloilo) and favorable conditions throughout Mindanao except for isolated drought areas in the north at Cagayan de Oro and Malaybalay. Crop index at 18th percentile at Cagayan de Oro suggests major yield losses and index at 3rd percentile at Malaybalay is an indicator of regional drought, not necessarily upland paddy.

B. 1981 Crop Season.

Agroclimatic crop conditions for upland rice during 1981 were very poor, there was regional drought impact and conditions were much worse than in 1982.

1) Bicol (about 7 percent national upland paddy production). Crop yields ranged from normal to above normal.

2) East Visayas (about 2 percent national upland paddy). Moderate drought impact at Catarman and Catbalogan (index values at 36th and 27th percentiles, respectively) resulting in below normal yields. Conditions above normal at Tacloban.

3) Central and West Visayas (about 3 percent national upland paddy). Except for normal conditions at Iloilo, crop indices in the 5th-20th percentile range (Cebu, Dumaguete, Roxas City and Tagbilaran) suggest significantly reduced yields and in the extreme crop failure.

4) Mindanao (50 percent national upland paddy). Agroclimatic crop condition indices ranging from 6th to 28th percentile suggest severe regional drought impact and major yield reductions.

7. Wet Season Maize.

Planting taken by AISC to coincide with major rainy season and is generally defined as May except for NE Monsoon dominated regions such as Catbalogan and Hinatuan (Oct); and Daet, Legaspi, Virac, Borongan, Catarman and Tacloban (Feb).

A. 1983 Crop Season (planted Feb-May, 1983).

Because rainfall data were only available through June 1983, wet maize is assessed for the total growing season in some regions (Feb-Apr Crop) and only partially through the growing season for the May planted crop (see table below). Agroclimatic indices for wet maize at the 5th percentile suggest a total crop failure for the February planted maize crop in the

Bicol and East Visayas regions (crop normally represents 7 percent of national wet maize). As indicated by crop condition indices ranging from the 2nd to 49th percentile in the remainder of the Visayas and Mindanao at the end of the crop vegetation stage, some isolated but not regional drought impact was being experienced.

B. 1982 Crop Season (planted Feb-May, 1982)

1) Bicol (about 3 percent national wet maize). No evidence of drought impact except subsistence crops grown in the vicinity of Masbate probably failed (crop index 3rd percentile).

2) East Visayas (about 4 percent national wet maize). Conditions generally favorable except in vicinity of Catbalogan where the crop index was at the 12th percentile indicating drought impact, major yield losses.

3) Central Visayas (about 11 percent national wet maize). Crop condition indices suggest normal crops to moderate drought impact (Cebu, 34th percentile and Dumaguete 27th percentile) throughout the region.

4) West Visayas (about 4 percent of national wet maize). Evidence for favorable crop conditions at Iloilo (crop index 82nd percentile), but crop failure at Roxas City (crop index, 3rd percentile).

5) Mindanao (about 60 percent national wet maize production). Maize crop conditions were normal to slightly below normal except for possible crop failure in vicinity of Cagayan de Oro (crop index, 6th percentile) and Malaybalay (crop index, 3rd percentile), again regional drought indicators.

C. 1981 Crop Season

Agroclimatic crop condition indices suggest that the 1981 planted wet maize crop was significantly below normal and a worse crop than was harvested later in 1982 (see table below). Drought impacted maize regions in the Bicol (crop indices 10th-20th percentile range) leading to major yield losses. Impacts in the Visayas were directly comparable to those in 1982.

Drought also impacted significant growing regions throughout Mindanao. As indicated by crop indices ranging from 10-30th percentile, drought impact ranged from major yield reductions to moderate yield reductions.

8. Dry Season Maize.

Planting taken by AISC to coincide with "normal" dry season generally Apr in NE Monsoon areas of Bicol and Eastern Visayas Regions, Oct/Nov in West and Central Visayas and Mindanao except for east coastal Hinatuan (May).

A. 1983/84 Crop (planted in 1983).

Agroclimatic crop condition indices for the April, 1983 planted dry maize crop suggest crop failure throughout the Bicol and East Visayas Regions.

B. 1982/83 Crop (Planted in 1982).

Agroclimatic crop condition indices suggest moderate to severe drought impact throughout Visayas and Southern Philippines.

1) Bicol (about 3 percent national dry maize). Essentially normal to above normal crop.

2) East Visayas (about 5 percent national dry maize). Drought to moderate drought impact and reduced yields near Borongan and Catarman (crop indices 17th-36th percentile), but conditions normal to above normal elsewhere.

3) Central and Western Visayas (about 11 percent National dry maize). Evidence for major yield reductions and even crop failure throughout the Regions. Crop indices ranged from 4th-35th percentile indicating moderate to severe drought impact.

4) Mindanao (about 46 percent national dry maize). Evidence for normal crop in Eastern Mindanao (Davao City, General Santos and Malaybalay), but crop failure or significantly reduced yields in Western Mindanao are

suggested by crop index values at 10th percentile for Cagayan de Oro, Dipolog, Zamboanga.

C. 1981/82 Crop (planted in 1981).

1) Bicol. Any maize grown near Masbate and Virac suffered significant drought impact. Conditions were essentially normal elsewhere.

2) East Visayas. Crop indices suggest normal maize crop except at Catarman where drought impact and well below normal yields were experienced (24th percentile).

3) West and Central Visayas. Well below normal maize yields due to drought probably existed throughout most of Regions. Crop indices at 25th percentile.

4) Mindanao. There was evidence for drought impact in Northern Mindanao in the vicinity of Cagayan de Oro and Malaybalay as a regional indicator, ranging from moderate yield losses (crop index 33rd percentile) to near crop failure (crop index 9th percentile), respectively.

9. AGROCLIMATIC/CROP CONDITION INDICES FOR PADDY (1981/83)

Regions	Station	1st Lowland Paddy		Upland Paddy		2nd Lowland Paddy	
		1981	1982	1981	1982	1981/82	1982/83
Bicol	Daet	68	—	72	—	—	14
	Legaspi	78	90	79	90	75	9
	Masbate	24	96	9	84	42	6
	Virac	18	72	63	78	51	12
East Visayas	Borongan	—	3	—	—	—	—
	Catarman	39	69	36	75	75	3
	Catbalogan	18	81	27	81	45	3
	Tacloban	65	68	84	50	75	3
W & C Visayas	Cebu	43	15	21	37	46	—
	Dumaguete	54	24	21	33	36	3
	Iloilo	26	88	49	94	26	8
	Roxas City	12	15	6	39	45	3
	Tagbilaran	9	33	9	33	55	5
E & N Mindanao	Hinatuan	50	—	28	—	68	10
W,C & S Mindanao	Cagayan de Oro	65	43	21	18	81	3
	Davao City	18	69	6	48	45	6
	Dipolog	15	12	12	42	33	27
	General Santos	9	63	6	72	66	9
	Malaybalay	27	3	24	3	87	3
	Zamboanga	15	21	15	30	18	6

Notes: — Missing Data; * Index Value at Vegetative Stage;
n/a Not Applicable

10. AGROCLIMATIC/CROP CONDITION INDICES FOR MAIZE (1981/83)

Regions	Station	Wet Maize			Dry Maize		
		1981	1982	1983	1981/82	1982/83	1983/84
Bicol	Daet	9	—	3	41	74	3
	Legaspi	14	73	2	55	32	14
	Masbate	60	3	n/a	12	90	23*
	Virac	20	88	14	14	58	5
East Visayas	Borongan	—	—	—	—	17	7
	Catarman	55	91	2	24	36	—
	Catbalogan	78	12	n/a	48	87	20*
	Tacloban	39	60	3	78	45	6
W & C Visayas	Cebu	43	34	48*	23	—	n/a
	Dumaguete	12	27	2*	18	24	n/a
	Iloilo	70	82	14*	26	35	n/a
	Roxas City	12	3	49*	27	9	n/a
	Tagbilaran	14	47	40*	76	4	n/a
E & N Mindanao	Hinatuan	65	—	n/a	75	—	6*
W,C & S Mindanao	Cagayan de Oro	33	6	20*	33	12	n/a
	Davao City	9	48	41*	57	42	n/a
	Dipolog	36	57	11*	93	12	n/a
	General Santos	21	39	n/a	57	54	n/a
	Malaybalay	61	3	38	9	45	n/a
	Zamboanga	33	42	8*	45	9	n/a

11. Summary of Current Conditions and Outlook Based AISC Regional Analysis

Drought in early 1983 impacted crops in NE Monsoon rainfall areas (Bicol and East Visayas) and moderate drought is developing in some SW Monsoon rainfall areas (West Visayas and most of West Mindanao). As noted above, the wet maize crop (Feb 83 planted) in Bicol and East Visayas Regions was probably close to a crop failure. The wet maize crop (May 83) experienced moderate drought impact in West Visayas and western areas of Mindanao; below normal yields can be expected, not major yield reductions. Depending on availbility of irrigation sources, the Upland Paddy (May-Jun planting) and First Lowland Paddy (Jun-Jul transplanting) are also experiencing moderate drought impact in West Visayas and western areas of Mindanao. In general, SW Monsoon rainfall during the 1983 season has been 20-25 percent below normal, but improved over 1982 rainfall conditions in the Central and Southern Philippines.

12. PLEASE CAPTION ALL RESPONSES FOR LOU STEYAERT, NOAA/ASSESSMENT AND INFORMATION SERVICES CENTER, FEDERAL BLDG., ROOM 200, 600 EAST CHERRY STREET, COLUMBIA, MO 65201.

(ORIGIN: AISC/NESDIS/NOAA/RCARTER)